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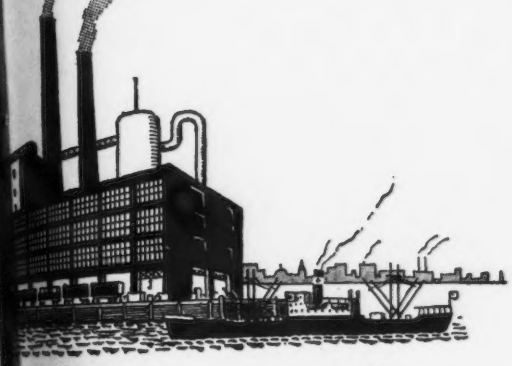
ECONOMIC GEOGRAPHY



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ECONOMIC GEOGRAPHY

VOL. 32 JULY, 1956 No. 3

AMERICAN ORCHARD AND VINEYARD REGIONS

Clarence W. Olmstead

Dr. Olmstead, who specializes in agricultural geography, is an assistant professor at the University of Wisconsin.

THE farmer is interested in the near-at-hand; the romanticist in the far-away. The geographer wants to know the connections of the thing at hand to the related things he can and cannot see. Having been raised on a small orchard farm, and been trained as a geographer, I have a desire to see the orchard farm in the total arrangement of its kind, and its connections to arrangements of other kinds.

But there is further reason for compilation of the maps here presented. Most of the world's land is used for agricultural purposes. Most of the world's people, still, are farmers. The commercialized methods of the few are spreading to the many. Commercialization begets specialization. In the United States, specialization in the agricultural use of land has developed at an increasing rate during the past half century. It has been encouraged by the increasing concentration of people in cities, by the growing demand for a variety of food and fibre materials of uniform high quality regardless of conditions for their production locally, and by the development of increasingly specialized techniques, machinery, and organization for producing, processing, advertising, and distributing these materials within a large, free-trade area. Each kind of specialized land use has become distributed in a distinctive but dynamic pattern. What are these patterns? How do they develop and change? What are the factors and processes involved and how do they operate?

In Anglo-America commercial orchards and vineyards are extremely concentrated in small but widely scattered areas. Why? Do not other areas possess those characteristics permitting of fruit growing? The distribution pattern has changed markedly since settlement. How, and why? Study is facilitated by the fact that these are not the erratic, short-term changes more common to annually planted crops, and by the tendency for evidences of former orchards and vineyards to remain for some time on the land.

A first step in studying the geography of orchards and vineyards is to measure and map their distribution. The United States Bureaus of the Census and of Agricultural Economics have published small scale dot maps which show the distribution of total orchard and vineyard acreage, and of numbers of fruit

and nut trees and vines, by individual species.[1] They do not show distribution in detail, nor do they attempt to measure or portray the relative significance of the use of land for orchards and vineyards, or the different combinations of particular orchard and vineyard crops within specific regions. These are purposes of the accompanying maps.

MEASUREMENT OF THE AGRICULTURAL USE OF LAND

In mapping agricultural activity, choice of the unit of measure poses the initial problem. Shall one measure the area used, the input of effort, or the output of product? For a full understanding of the geography of agriculture, all three kinds of measurement, each with its many components and variations, are necessary. Standardization of measurement among studies of different types of agriculture in different areas is desirable. But the objectives of a given study, the nature of the particular uses of land in the specific areas being studied, and the kinds of pertinent data available may make it necessary or desirable to emphasize one of the three kinds of measures, or of its variants.

There is no equable, quantitative measure of the output of orchards and vineyards, or of any large number of diverse agricultural products. How equate bushels or pounds of cherries with bushels or pounds of pecans, or either with bushels or pounds of corn? Shall the pecans or corn be shelled or the cherries pitted? How shall the corn fodder be measured? One might reduce all to calories. But calories serve to measure one phase of diet, not agricultural use of land. In terms of the use of land, the production of a million calories from apples is not equivalent to the production of a million calories from oranges, coffee, or potatoes. Perhaps the dietician will one day compute a unit which measures both the growth and energy values of food. It would be useful in the study of population and food supply but, again, would be no measure of the agricultural use of land. What to do, for instance, with coffee, tung nuts, or rubber?

Value of production reduces bushels, pounds, calories, vitamins, or acres all to a common denominator. There remain, however, the problems of exchange ratios among different currencies, or among the different values of the same currency at different times. Furthermore, should one use gross or net value of production? How can the latter be determined? Farmer A buys beef feeder stock from Farmer B and corn from Farmer C. Shall the cost of both stock and feed be subtracted from the selling price of Farmer A's fattened beef? If so, should the orchardist subtract the cost of nursery stock, and from which year's crop? What shall be done with the considerable cost of fertilizers, insecticides, or irrigation water?[2]

Due largely to the hazards of weather, production of fruits and nuts from year to year is highly irregular, much more so than that of most field crops or livestock products. The variations are uniform neither in time nor in area. Consequently, production data for one year do not fairly represent the typical distribution of production over the

[1] U. S. Census of Agriculture: 1950, Vol. V, Special Reports, Part 6, Agriculture 1950—A Graphic Summary, pp. 31–33.

[2] In a recent seminar at the University of Wisconsin, Arlin Fentem proposed a measure of "value-added" which is useful for study of the mixed crop-livestock agriculture of the corn belt. He subtracts from the value of livestock sold, the cost of livestock and feed purchased. To refine the measure further and apply it widely would require more complete data than are available from the United States Census or other sources.

United States. Although recent state surveys by offices of the Agricultural Estimates Division of the Agricultural Marketing Service, United States Department of Agriculture,[3] are very useful, the only uniform, nation-wide data on value of production of orchard and vineyard crops are those collected by the United States Census of Agriculture at five-year intervals. To compute the mean output for as few as four years would involve at least a 15-year period and would conceal both trend and current status. Value of production for the most recent year available is used as the unit of measure in one of the accompanying maps (Fig. 4), principally to indicate the varying ratio between acreage and value of output, especially between western irrigated and eastern unirrigated districts.

There is need for classification, mapping, and geographic analysis of the input, or effort expended in the agricultural use of the land. The terms intensive and extensive farming are often used but infrequently defined. What are the conversion factors among manpower, animal power, machine power, management, skill, technology, tools, quality of seed or breeding stock, soil improvement programs, or other expressions of capital, all within the total expended effort or intensity of use? How is the total effort apportioned among the associated crops and livestock which make up the total enterprise of a given farm unit? The data available do not permit consideration of these problems in the initial mapping of orchards and vineyards. Agricultural economists have utilized these approaches to the study of types of farming. Agricultural geographers cannot overlook the concept in the field analysis of the agriculture in any area.[4]

All but one map in the accompanying series utilize area as the unit of measure. Regardless of the restrictions imposed by the nature of available data, it is logical to map the quantity of land used for orchards and vineyards, and the crop combinations, before attempting an analysis of the varying intensity and productivity of that use. The maps are an attempt to delimit and regionalize orchard or vineyard crop-combination areas.

MAPPING OF ORCHARD AND VINEYARD AREAS

The only source of uniform data on orchards and vineyards recorded for small unit areas throughout the nation is the United States Census of Agriculture. Published for every fifth year since 1930, by counties, are (1) the composite acreage in orchards, groves, vineyards, and planted nut trees, and (2) for each of the major individual species, the number of trees and quantity harvested. Value of production is given for the separate fruits for 1944 and 1949. Data in these categories, except value of production, may be obtained in manuscript form by paying the cost of photostatic reproduction, for minor civil divisions, for the years 1935, 1940, and 1945, but not for 1950 or 1955. Although additional useful data have been collected by several state offices of the Agricultural Estimates Division, United States Department of Agriculture, they are neither uniform nor complete for the country.

[3] Formerly known as the Federal-State Crop and Livestock Reporting Service of the Bureau of Agricultural Economics, U. S. Department of Agriculture.

[4] See I. G. Davis: *Types of Farming and Type of Farming Areas in Connecticut*, Bulletin 213, Agricultural Experiment Station, Storrs, Connecticut, 1936. In a current field study of the Lake Erie Fruit and Vegetable Belt, Richard E. Dahlberg of Southern Illinois University is using "productive man work units" on individual farms as one approach to the analysis of agriculture.

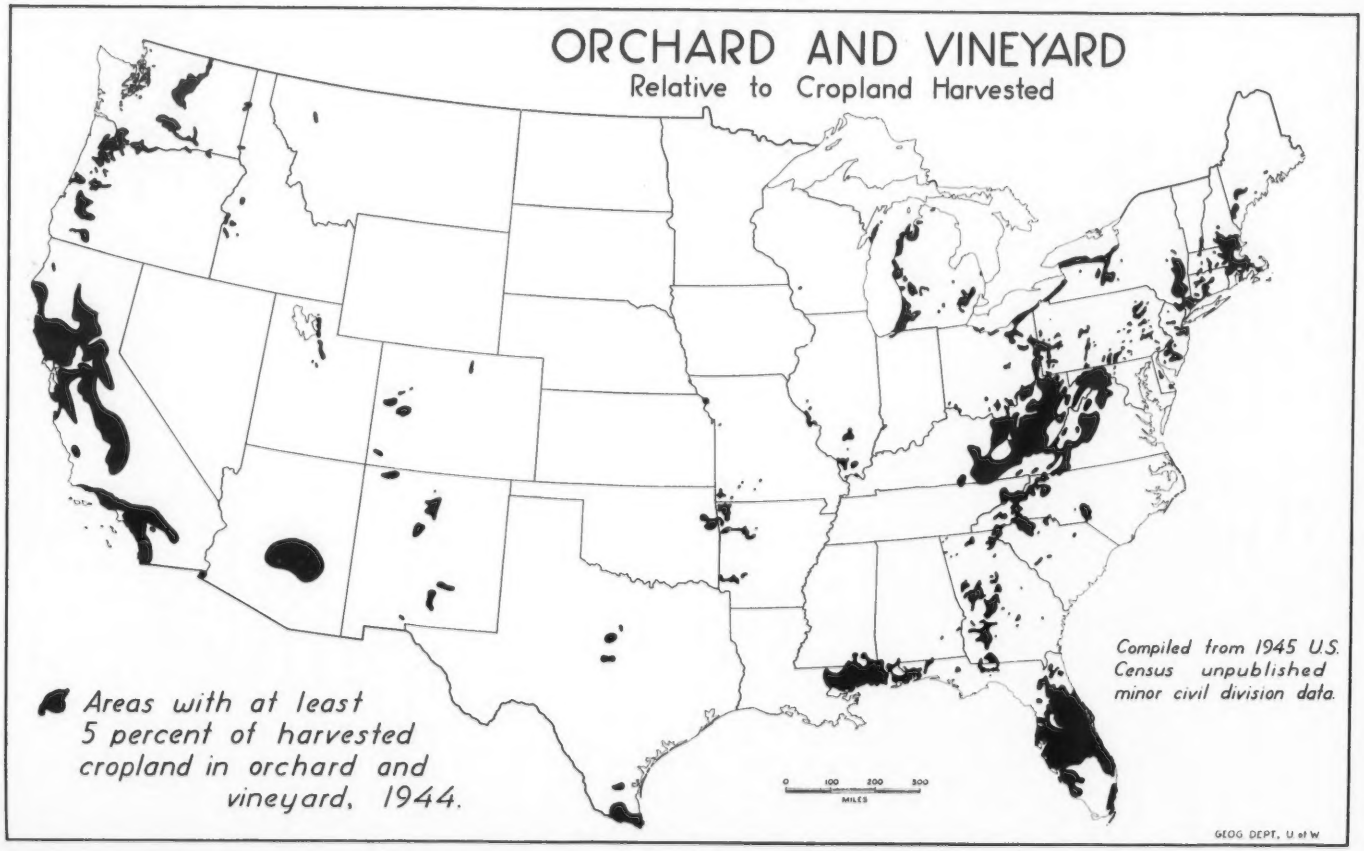
ORCHARD AND VINEYARD
Relative to Cropland Harvested
Areas with at least 5 percent of harvested cropland in orchard and vineyard, 1944.
Compiled from 1945 U.S. Census unpublished minor civil division data.
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FIG. 1.

The orchard and vineyard areas shown in black in Figures 2–4 and in white in Figures 5–9 were compiled from unpublished United States Census data for minor civil divisions for the year 1945, the latest uniform, detailed data available. Acreage was plotted directly on Bureau of the Census minor civil division maps of the various states. Total land area was also recorded[5] and the ratio of land in orchard and vineyard to total land computed.

Isopleths were drawn on the state maps separating the orchard and vineyard areas into categories having at least 2.5 per cent, 5 per cent, 10 per cent, and 20 per cent, respectively, of their total land area in orchards or vineyards. These categories were selected after consideration of the range of values on all the maps and after field observation in several areas. Any land area of approximately 36 square miles (a normal, minimum minor civil division) having at least 2.5 per cent of its total land devoted to orchard or vineyard is assumed to be or to contain an "orchard and vineyard area." This ratio is equal to one acre in 40. In much of the United States, 40 acres is a basic unit of land and of farm subdivision; east of the Prairies it was for long a typical farm size. Until recent decades, such a typical 40-acre farm often included an orchard. If the latter were less than an acre in size, it probably was designed as a "kitchen orchard" to supply the needs of the farm family. If larger than an acre, it likely constituted a part of a mixed commercial enterprise, a "farm orchard" obligated to produce a surplus for sale. With the increasing specialization and commercialization of the past half century, most kitchen and farm orchards have disappeared (along with the churn and "butchering day"). Orchards have tended to become concentrated on commercial fruit farms, and such farms have become localized within limited areas. But the ratio of orchard to total land, referred to above, remains pertinent. Whether one acre in each 40 bears orchard and vineyard, or whether one 40-acre block in each 2.5 square miles (1600 acres) is so used, the result is functionally and visibly significant. Farmers in such an area think in terms of frost hazards, spray programs, fruit harvest labor, and fruit markets. In addition to the obvious orchards and vineyards themselves, the area exhibits specialized tools, structures, and techniques for production and marketing of a specialized product. The fact that another use of land may cover more area or produce more income notwithstanding, utilization of at least 2.5 per cent of total land for orchard or vineyard is a reasonably valid indication of the presence of a commercial development which imparts unique characteristics to an area. Such an area is here defined as "an orchard and vineyard area."

The individual state-map work sheets, most of them at scales of 1:1,000,000 or larger, obviously permit much greater detail of mapping than can be shown on the accompanying small-scale maps. In addition to facilitating accurate generalization, the work sheets will be useful for such comparative field studies of individual regions as become possible. The orchard and vineyard areas shown in Figures 2–4 are simply areas in which at least 2.5 per cent of the total land is planted with orchard trees or vines. The larger scale maps, Figures 5–9, permit representation of a second and higher category, those areas in which at least 10 per cent of the total land is devoted to orchard or vineyard.

[5] Land areas of minor civil divisions are from *Areas of the United States, 1940*, Bureau of the Census, Washington, 1942.

Various kinds of evidence were used in helping to refine the isopleths on the state-map work sheets. Several map series recently published by the United States Geological Survey and the Army Map Service at scales from 1:24,000 to 1:62,500 show land in orchards and vineyards. Coverage is fairly complete for most orchard and vineyard regions except in the western Great Lakes, Mississippi Valley, Ozark-Ouachita, Southeastern Deciduous, Rocky Mountains, and Cascade Valleys areas. Older large-scale maps, although lacking orchard data, were helpful for interpreting the areal distribution of minor civil division totals of orchard acreage, especially in mountainous areas. Aerial photographs were utilized for some areas, especially in Michigan. Many studies, even though some lack current statistics, were helpful in suggesting or verifying pertinent relationships.[6]

[6] A number of studies have been made by geographers, for example: Warren Strain: "The Florida Citrus Crop," *Econ. Geog.*, Vol. 18, 1942, pp. 17–28; Clifford M. Zierer: "The Citrus Industry of the Los Angeles Basin," *ibid.*, Vol. 10, 1934, pp. 53–73; Hoyt Lemons and Rayburn D. Tousley: "The Washington Apple Industry," *ibid.*, Vol. 21, 1945, pp. 161–182 and Vol. 21, 1945, pp. 252–268; Howard F. Gregor: "Agricultural Shifts in the Ventura Lowland of California," *ibid.*, Vol. 29, 1953, pp. 340–361; and Dalias A. Price: "The Commercial Orchard Economy of Southern Illinois," Ph.D. dissertation, University of Wisconsin, 1954. Representative of studies published by state agricultural colleges and experiment stations are Arthur W. Van Dyke: *Connecticut Tree Fruits*, University of Connecticut, College of Agriculture, Agricultural Extension Service, Storrs, 1949, and T. L. Senn and J. Sam Taylor: *The Commercial Peach Industry in South Carolina*, South Carolina Agricultural Experiment Station of Clemson Agricultural College, Clemson, S. C., 1951. Among the more complete of a number of census and analytical studies by state offices of the Agricultural Estimates Division of the Agricultural Marketing Service is Herman A. Swedlund, Emery C. Wilcox, Bruce M. Graham and Robert McGregor: *Washington Tree Fruits*, Washington Crop and Livestock Reporting Service, Seattle, 1952, and *Arizona Citrus*, a survey conducted by Evan V. Jones and M. Vincent Lindquist of the Federal Crop Reporting Service, Arizona, with the aid of the University of Arizona and the Desert Grapefruit Industry Committee, Inc., Phoenix, 1949.

ORCHARD AND VINEYARD CROP COMBINATIONS

The orchard and vineyard areas represented in Figures 2–9 were compiled largely on the basis of unpublished 1945 Census of Agriculture data recorded by minor civil divisions. The acreage and production symbols on these maps were compiled from 1950 Census of Agriculture data recorded by counties. This departure from absolute comparability of statistics seems justified in order to establish the distributional arrangement of orchard and vineyard areas as accurately as possible and, at the same time, to represent the most recent acreage, production, and crop combination data which approximately fit those areas.

With a few exceptions, the acreage and production symbols represent totals for whole counties or groups of whole counties, all or a significant part of which are included within the associated orchard and vineyard area. In some cases, especially in California, greater accuracy in regionalization would have resulted from the subdivision of counties along minor civil division lines. This was done in a few of such cases, for example, in Alachua and Marion Counties, Florida, where it was possible to allocate the 1950 county totals accurately among their minor civil divisions. In other cases, divisions along the county boundaries may blur areal differences that in reality are sharp. For example, in Figure 8, some apple acreage that is contiguous with the Pajaro Valley is represented in the symbol for the Middle Salinas Valley because the apple acreage is within Monterey County whose major orchard area is an interior almond district. Some of the smaller and less specialized orchard and vineyard areas of eastern United States are represented by pro-

portionally large acreage symbols due to the inclusion, through the use of county totals, of a number of scattered orchards lying outside the area of concentration. It was decided, however, that these minor compromises of detail were more than compensated for by the advantage of the recency of the 1950 county data from which acreage and production were compiled.

The separate fruits and nuts are enumerated in the Census not by acreages but by numbers of trees or vines. It is obvious that, in terms of the use of land, one hundred grape vines are not the equivalent of one hundred peach trees. It is just as true that one hundred peach trees are not the equivalent of an equal number of apple, tung, grapefruit, or walnut trees. Therefore, in order to establish the proportional significance, in terms of land use, of each crop in a combination, it was necessary to convert all tree and vine numbers to equivalent acreages. This was done with the help of numerous persons and sources. The various state offices of the Agricultural Estimates Division of the Agricultural Marketing Service were most helpful. They supplied cautious estimates of plant-acre ratios for the various fruits and nuts, or data from which estimates of such ratios could be made. The California, Arizona, Texas, and Florida offices compile species data by acreage. Recent surveys have been made in several other states which give acreages of the separate fruits and nuts by counties. Specialists associated with agricultural experiment stations and university departments of horticulture provided information. Field observations were made in a number of areas, especially the Great Lakes, Northeast, Appalachian, Southeastern Deciduous, and Florida. Checks were made with 1945 census data by minor civil divisions, it being possible to isolate areas within which the total orchard acreage is com-

TABLE I

APPROXIMATE NUMBER OF TREES OR VINES PER ACRE

	Eastern U.S.	*Western U.S. except Calif.*	*California*[1]
Almonds	.....	.....	71
Apples	30–40	40–50	63
Apricots	.....	75–100	...
Avocados	.....	.....	81
Cherries, all	.....	50–90	78
Sweet	50–75	50–90	...
Tart	85–110	.....	...
Figs	.....	.....	54
Filberts	.....	85–90	...
Grapes, all	410–700	500–700	476
Raisin	.....	.....	482
Table	.....	.....	461
Wine	.....	.....	476
Grapefruit	55–65	.....	85
Lemons	.....	.....	96
Olives	.....	.....	59
Oranges	55–65	.....	88
Peaches	85–110	85–110	96
Pears	80–90	85–100	98
Pecans	12–18	60 (New Mexico)	...
Plums	85–100	90–110	110
Prunes	.....	90–110	80
Tangerines and Mandarins	55–65	.....	...
Tung nuts	65–100	.....	...
Walnuts	.....	18–25	26

[1] Average numbers computed from Census of Agriculture data for 1949.

prised primarily of a single species. This technique was also used where possible with the 1950 county data. In working out the ratios for each county, the sum of the computed acreages of the separate fruits or nuts was always made to equal the total combined acreage reported in the census.

The plant-acre ratios for a given species vary from county to county, although there is considerable uniformity within, or even among, regions. The general range of ratios used is shown in Table I. Those for California, computed from Census of Agriculture data for 1949, are included merely for purposes of comparison. The pie charts for California, Arizona, Texas, and Florida areas on the maps were computed directly from Agricultural Estimates Division acreage data.[7]

Absolute accuracy is not claimed for the proportional division, by crops, of the acreage symbols in Figures 2, 3, and 6–9. It is believed, however, that the maps are the most accurate representation that can be made, and that they portray for the first time a significant aspect of the geography of American agriculture. On them "orchard and vineyard areas" are defined, and for each area the approximate total acreage and the proportional significance of each component in the orchard and vineyard crop association are shown. The typical crop associations on individual farms, whether or not they be exclusively orchard and vineyard farms, obviously are not shown. This, together with other significant phases of orchard land use, can only be investigated in the field.

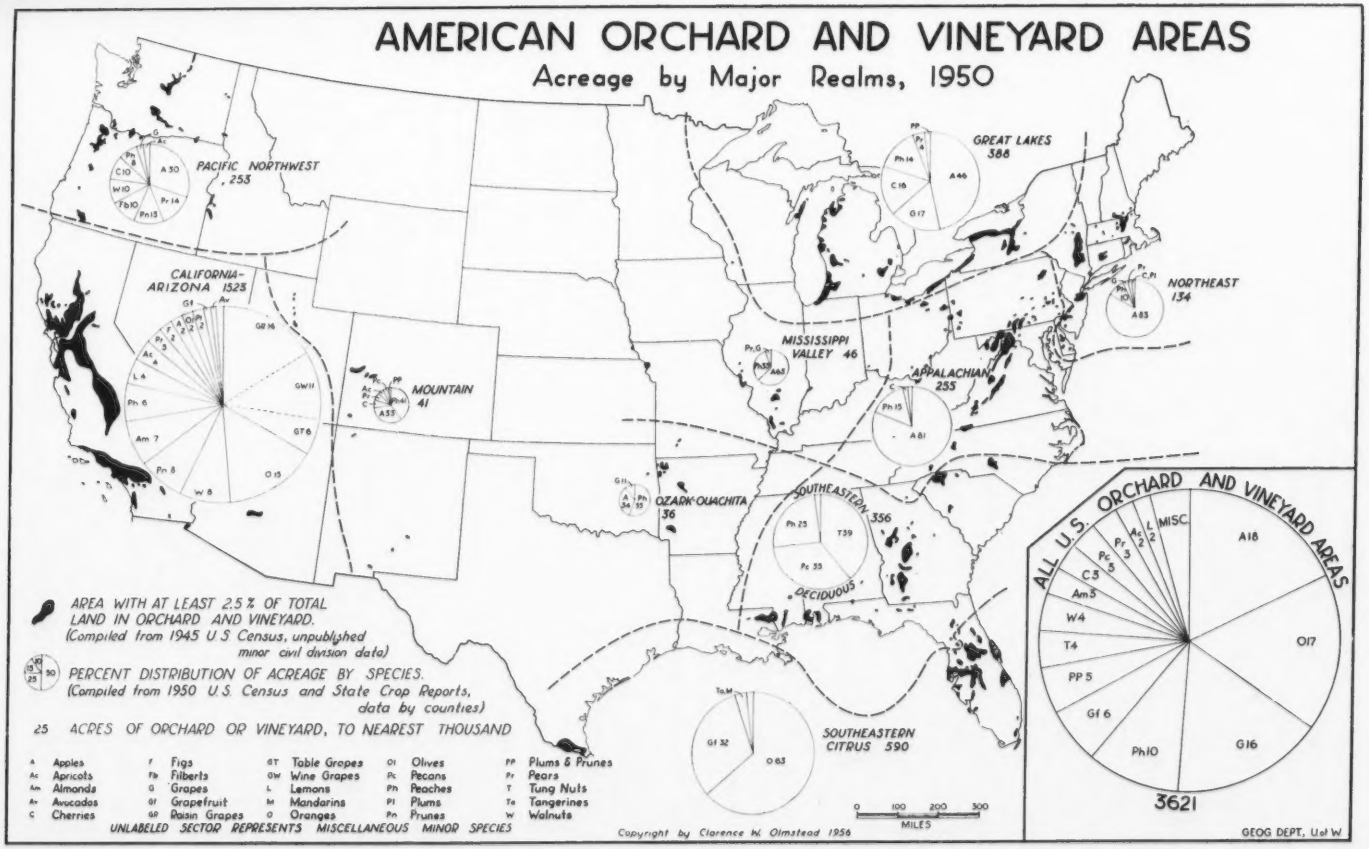
[7] These data, collected and compiled by statisticians expert in dealing with tree and vine crops, are almost certainly more accurate than acreages computed from tree and vine numbers in the Census of Agriculture. Although other offices of the Agricultural Estimates Division are also collecting and compiling orchard and vineyard statistics, they were not complete nor uniform enough to replace Census data for this study.

REGIONALIZATION

Figure 2, Figure 3, and Figures 5–9 combined, represent three degrees of regionalization of orchard and vineyard areas. The terminology is that suggested by Whittlesey and co-authors for compages.[8] The terms realm and province which are applied in Figures 2 and 3, and the terms district and locality which might be applied in reading Figures 5–9, are used merely as convenient nomenclature for a hierarchy of groupings of orchard and vineyard areas. The sole purpose of the groupings is to introduce space-order into the picture of orchard and vineyard distribution. The criteria used are similarity of crop combination (in area, not necessarily on farms), and juxtaposition in space. Contiguous or adjacent areas are separated if they possess markedly different crop associations. Examples are the contiguous areas in central California and central New York, and the adjacent ones in central Georgia.

Along the subtropical margins of the country, orchard farming is devoted primarily to the evergreen citrus species. This is completely true in central Florida where oranges are dominant and grapefruit secondary, and in the Lower Rio Grande Valley where acreage of the two crops is more nearly equal but in the reverse order. Grapefruit and orange groves comprise most of the orchard area in the Salt River Valley of Arizona, although a deciduous crop, grapes, enters the combination. In southern California, likewise, citrus are dominant, but here dry summers

[8] Derwent Whittlesey: "The Regional Concept and the Regional Method," Chapter 2 in *American Geography, Inventory and Prospect*, edited by Preston E. James, Clarence F. Jones and John K. Wright, Syracuse, 1954.


AMERICAN ORCHARD AND VINEYARD AREAS
Acreage by Major Realms, 1950
PACIFIC NORTHWEST 253
CALIFORNIA-ARIZONA 1523
MOUNTAIN 41
GREAT LAKES 388
MISSISSIPPI VALLEY 46
APPALACHIAN 255
NORTHEAST 134
OZARK-OUACHITA 36
SOUTHEASTERN 356
DECIDUOUS
SOUTHEASTERN CITRUS 590
ALL U.S. ORCHARD AND VINEYARD AREAS
3621
AREA WITH AT LEAST 2.5 % OF TOTAL LAND IN ORCHARD AND VINEYARD.
(Compiled from 1945 U.S. Census, unpublished minor civil division data)
PERCENT DISTRIBUTION OF ACREAGE BY SPECIES.
(Compiled from 1950 U.S. Census and State Crop Reports, data by counties)
25 ACRES OF ORCHARD OR VINEYARD, TO NEAREST THOUSAND
A Apples
Ac Apricots
Am Almonds
Av Avocados
C Cherries
F Figs
Fk Filberts
G Grapes
Gf Grapefruit
GR Raisin Grapes
GT Table Grapes
GW Wine Grapes
L Lemons
M Mandarins
O Oranges
Ol Olives
Pc Pecans
Ph Peaches
Pl Plums
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0 100 200 300
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GEOG DEPT, U of W

FIG. 2.

and a variety of altitude-exposure combinations permit (and the expanding local market encourages) production of a variety of other evergreen and deciduous tree crops. Lemons, walnuts, Valencia oranges, and avocados dominate the acreage in the coastal areas; Valencia and navel oranges in the interior. There is significant production of oranges in the Tulare-Kern district of the San Joaquin Valley (Fig. 8), and minor production in the outer Mississippi Delta.

The United States produces about 40 per cent of the world's oranges, 45 to 50 per cent of the lemons, and nine-tenths of the grapefruit. Since 1948, Florida has accounted for about 60 to 70 per cent of American orange production, California for most of the remainder.[9] Florida's share of national grapefruit production has ranged from about two-thirds in 1948–50 to nearly nine-tenths in the 1951–52 season. The Lower Rio Grande share of about 36 per cent during 1938–48 almost disappeared after the disastrous winter freeze of 1951–52. It climbed again to more than 8 per cent in 1954–55. Most of the country's lemons are produced in southern California.

All other American orchard and vineyard areas are characterized by associations of deciduous fruits or nuts. There are two partial exceptions: the importance of oranges in the Tulare-Kern district of the San Joaquin Valley, and the significant production of olives in this district and in the Northern and Lower Eastern districts of the Sacramento Valley.

In most of the humid East, the crop association is comprised of a few of the more hardy fruits, namely apples, peaches, pears, plums, cherries, and grapes. In the Northeast, the Appalachians, and the Mississippi Valley, the association is a two-crop one, with apples dominant and peaches secondary. In the New Jersey–Delaware and Southern Illinois–Indiana provinces, peaches comprise a third or more of the total orchard acreage (Fig. 3). In only one included area, however, the Drift Plains district of southern Illinois, does the acreage of peaches exceed that of apples (Fig. 6). In the Ozark Hills and Vincennes districts of southern Illinois-Indiana, and in southern New Jersey, the ratio of peach to apple acreage is about four out of five. In a number of other areas, including Delaware, several districts in Eastern Pennsylvania, the Cumberland Valley area of Pennsylvania-Maryland, the Upper Potomac district, and the Albemarle-Nelson locality of the Central Virginia Blue Ridge district (locally called the Piedmont), peaches comprise from a fifth to a fourth of the total orchard acreage. Elsewhere in the Northeast, Appalachian, and Mississippi Valley realms, although they consistently rank as the second orchard crop, peaches represent a minor diversification of apple production.[10]

In the Nashville and Clarksville districts of the Ozark-Ouachita area,

[9] Data from "Agricultural Statistics," 1951 and 1954, and from reports of the Agricultural Estimates Division, Agricultural Marketing Service, U. S. Department of Agriculture.

[10] It is not wholly realistic to separate peach and apple acreages in Northeastern areas. The normal profitable bearing period for a peach orchard in these areas is from about four to 15 years; for an apple orchard, from age eight or ten to 30 or more. Since apple trees also attain much larger size and, consequently, must be planted much farther apart, it has been a fairly common practice to use peach trees as "fillers" in apple orchards. For example, an orchard site may be surveyed so as to provide tree positions at 20-foot intervals in rows 20 feet apart. But only alternate positions in alternate rows will be planted with apple trees, all other positions (75 per cent of the total) being used for peach trees. The latter will complete much of their productive life before the more slowly maturing but larger-growing apple trees reach profitable bearing age and require the space provided by removal of the peach trees.

the order of the two-crop combination is reversed, apples being a minor diversification of peach production. In the Northwestern Arkansas district, apples are primary, grapes important, and peaches minor.

In the Great Lakes realm, the orchard and vineyard crop association is more diversified than elsewhere in the East, less so than in the Far West. The Lake Ontario Shore and Southeastern Michigan areas approach one-crop dominance, apples occupying approximately 70 and 80 per cent of the acreages, respectively. In the first province, however, cherries, peaches, pears, plums, and grapes are all significant minor crops. Several smaller areas also approach one-crop dominance. In the Grand Traverse locality of the Northwestern Michigan district, and in Door Peninsula, the dominant crop is cherries. These areas consistently rank first and third, respectively, in national red tart cherry production, the Lake Ontario Shore province accounting for much of the remainder. In the Lake Erie Grape Belt and in the Keuka-Seneca district of the Finger Lakes, grapes comprise about 75 and 70 per cent, respectively, of total orchard and vineyard acreage. These areas, along with Southwestern Michigan, have for many years accounted for most Concord grape production in the United States, although the important production of Washington's Yakima Valley is increasing more rapidly. In the Central Western Michigan district, the Northwest Shore of the Northwestern Michigan district, and the Central and Eastern Ohio Shore districts along Lake Erie, apples comprise more than half the orchard and vineyard acreage. In each of these areas, however, a second fruit crop ranks high and others are significant.

The most diversified and well-balanced crop combinations of the Great Lakes realm are those of the Southwestern Michigan and Oceana-Mason districts of Western Michigan, and the Western Ohio district of the Erie Shore. In each of these areas, the two ranking fruit crops occupy comparable acreages, a third crop ranks relatively high, and at least two other species are significant.

In the South outside of the highlands, deciduous orchard areas tend to specialize in a single crop. The major exception is the Central Georgia peach district where, in all three localities, pecans occupy a third or more of the total orchard acreage. In the Carolina Piedmont and Sandhill districts, however, peaches are supreme, as are pecans throughout the Southeastern Pecan province. In the Gulf Coast Tung province, pecans occupy a fifth or more of the total acreage in some districts.

Crop associations in the small Rocky Mountain orchard areas are more like those of the East than those of the Far West. The combination in the Wasatch Valleys is not unlike that in Southwestern Michigan, except that the apricots of the former are substituted for the grapes of the latter. In the Grand River Valley of western Colorado peaches are supplemented by several minor crops. In the more elevated North Fork Gunnison, Cortez, and Farmington districts peaches are secondary to apples. Of the small districts in Southern New Mexico, the one in the Rio Grande Valley is devoted primarily to pecans, those in the Hondo and Tularosa Valleys to apples.

In comparison with eastern deciduous orchard and vineyard regions, the irrigated tree and vine crop areas of the Far West are characterized by larger extent, greater crop diversity, and higher yields. The latter difference is suggested by Figure 4; the first two comparisons may be noted in Figures 2, 3, and 5–9. Crop diversity is per-

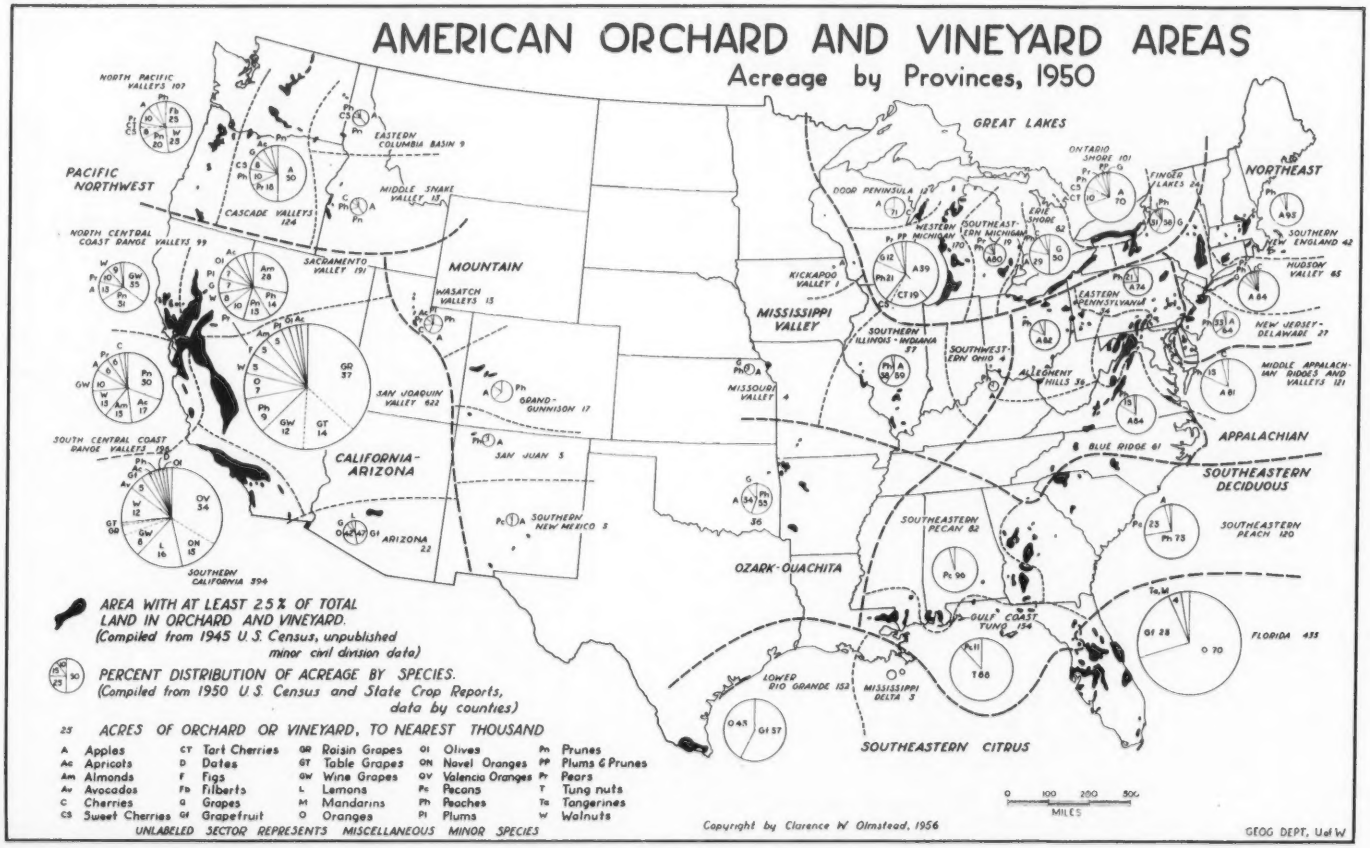
AMERICAN ORCHARD AND VINEYARD AREAS
Acreage by Provinces, 1950
NORTH PACIFIC VALLEYS 107
PACIFIC NORTHWEST
EASTERN COLUMBIA BASIN 9
MIDDLE SNAKE VALLEY 15
CASCADE VALLEYS 124
NORTH CENTRAL COAST RANGE VALLEYS 99
SACRAMENTO VALLEY 191
MOUNTAIN
WASATCH VALLEYS 13
SAN JOAQUIN VALLEY 622
GRAND-GUNNISON 17
SAN JUAN 5
SOUTH CENTRAL COAST RANGE VALLEYS 126
CALIFORNIA-ARIZONA
SOUTHERN CALIFORNIA 394
ARIZONA 22
SOUTHERN NEW MEXICO 5
GREAT LAKES
ONTARIO SHORE 101
DOOR PENINSULA 12
WESTERN MICHIGAN
SOUTHEASTERN MICHIGAN
ERIE SHORE 62
FINGER LAKES 24
NORTHEAST
SOUTHERN NEW ENGLAND 42
HUDSON VALLEY 65
KICKAPOO VALLEY 1
MISSISSIPPI VALLEY
EASTERN PENNSYLVANIA
NEW JERSEY-DELAWARE 27
SOUTHERN ILLINOIS-INDIANA 37
SOUTHWESTERN OHIO 4
ALLEGHENY HILLS 35
MIDDLE APPALACHIAN RIDGES AND VALLEYS 121
MISSOURI VALLEY 4
APPALACHIAN
BLUE RIDGE 61
SOUTHEASTERN DECIDUOUS
SOUTHEASTERN PECAN 62
SOUTHEASTERN PEACH 120
OZARK-OUACHITA
GULF COAST TUNG 134
FLORIDA 435
LOWER RIO GRANDE 152
MISSISSIPPI DELTA 3
SOUTHEASTERN CITRUS
0 100 200 500
MILES
AREA WITH AT LEAST 2.5% OF TOTAL LAND IN ORCHARD AND VINEYARD.
(Compiled from 1945 U.S. Census, unpublished minor civil division data)
PERCENT DISTRIBUTION OF ACREAGE BY SPECIES.
(Compiled from 1950 U.S. Census and State Crop Reports, data by counties)
25 ACRES OF ORCHARD OR VINEYARD, TO NEAREST THOUSAND
A Apples
Ac Apricots
Am Almonds
Av Avocados
C Cherries
CS Sweet Cherries
CT Tart Cherries
D Dates
F Figs
Fb Filberts
G Grapes
Gf Grapefruit
GR Raisin Grapes
GT Table Grapes
GW Wine Grapes
L Lemons
M Mandarins
O Oranges
Ol Olives
ON Navel Oranges
OV Valencia Oranges
Pc Pecans
Ph Peaches
Pl Plums
Pn Prunes
PP Plums & Prunes
Pr Pears
T Tung nuts
Te Tangerines
W Walnuts
UNLABELED SECTOR REPRESENTS MISCELLANEOUS MINOR SPECIES
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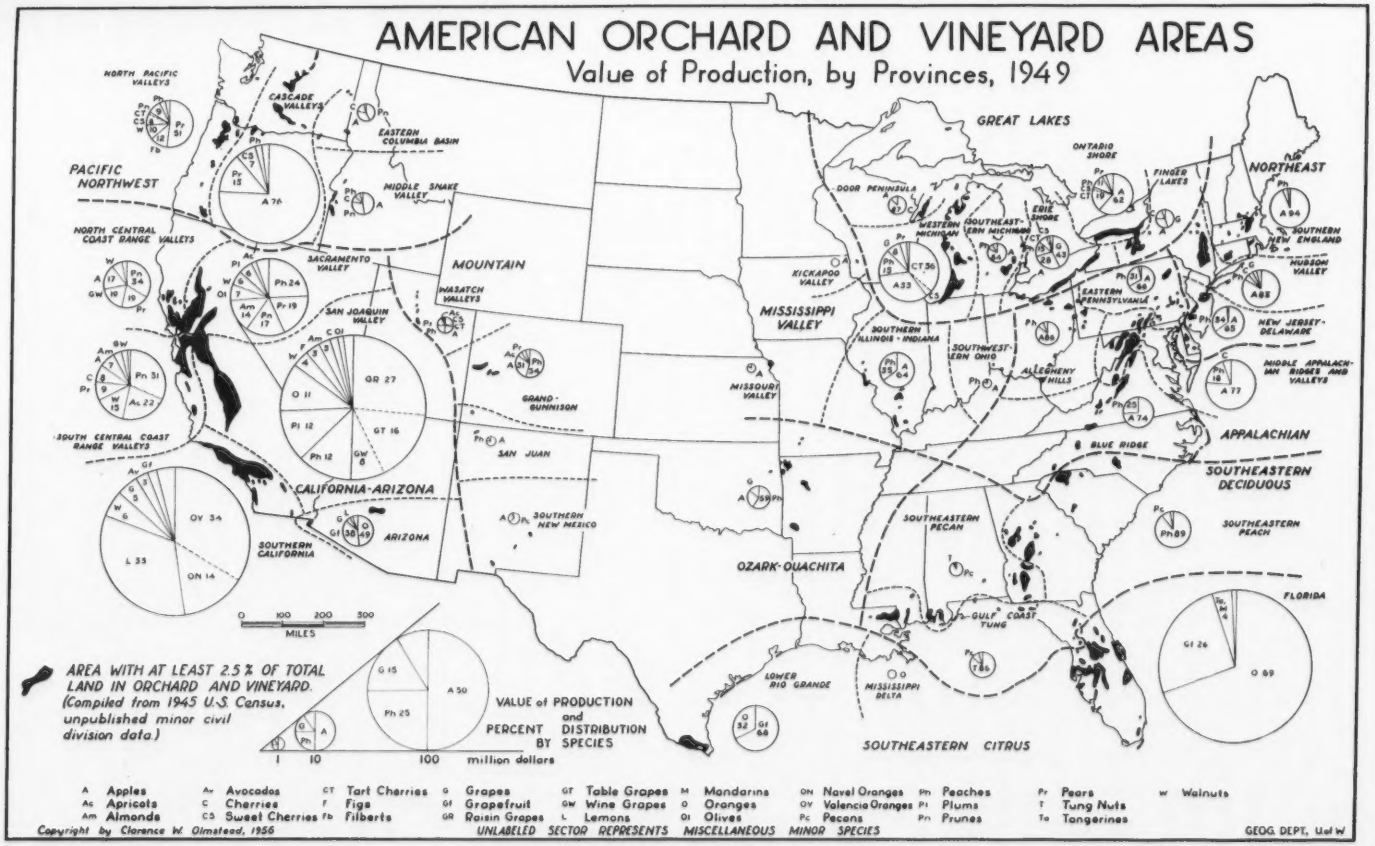
FIG. 3.


AMERICAN ORCHARD AND VINEYARD AREAS
Value of Production, by Provinces, 1949
NORTH PACIFIC VALLEYS
CASCADE VALLEYS
EASTERN COLUMBIA BASIN
PACIFIC NORTHWEST
MIDDLE SNAKE VALLEY
NORTH CENTRAL COAST RANGE VALLEYS
SACRAMENTO VALLEY
MOUNTAIN
WASATCH VALLEYS
SAN JOAQUIN VALLEY
GRAND-GUNNISON
SAN JUAN
SOUTH CENTRAL COAST RANGE VALLEYS
CALIFORNIA-ARIZONA
SOUTHERN NEW MEXICO
SOUTHERN CALIFORNIA
ARIZONA
GREAT LAKES
ONTARIO SHORE
FINGER LAKES
NORTHEAST
DOOR PENINSULA
WESTERN MICHIGAN
SOUTHEASTERN MICHIGAN
ERIE SHORE
SOUTHERN NEW ENGLAND
HUDSON VALLEY
KICKAPOO VALLEY
MISSISSIPPI VALLEY
EASTERN PENNSYLVANIA
SOUTHERN ILLINOIS - INDIANA
SOUTHWESTERN OHIO
NEW JERSEY-DELAWARE
ALLEGHENY HILLS
MISSOURI VALLEY
MIDDLE APPALACHIAN RIDGES AND VALLEYS
APPALACHIAN
BLUE RIDGE
SOUTHEASTERN DECIDUOUS
SOUTHEASTERN PECAN
SOUTHEASTERN PEACH
OZARK-OUACHITA
FLORIDA
GULF COAST TUNG
LOWER RIO GRANDE
MISSISSIPPI DELTA
SOUTHEASTERN CITRUS
0 100 200 300
MILES
AREA WITH AT LEAST 2.5 % OF TOTAL LAND IN ORCHARD AND VINEYARD. (Compiled from 1945 U.S. Census, unpublished minor civil division data)
VALUE of PRODUCTION and DISTRIBUTION BY SPECIES
PERCENT
1 10 100 million dollars
A Apples
Ac Apricots
Am Almonds
Av Avocados
C Cherries
CS Sweet Cherries
CT Tart Cherries
F Figs
Fb Filberts
G Grapes
Gf Grapefruit
GR Raisin Grapes
GT Table Grapes
GW Wine Grapes
L Lemons
M Mandarins
O Oranges
Ol Olives
ON Navel Oranges
OV Valencia Oranges
Pc Pecans
Ph Peaches
Pl Plums
Pn Prunes
Pr Pears
T Tung Nuts
Ta Tangerines
W Walnuts
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UNLABELED SECTOR REPRESENTS MISCELLANEOUS MINOR SPECIES
GEOG. DEPT., U. of W.

FIG. 4.

mitted by the variety of altitude-exposure combinations, the mild winter temperatures, and the controlled application of water. These factors, especially the last, contribute toward high yields. High yields, in turn, encourage specialization in tree and vine crops. Specialization in a variety of crops has led to large acreages.

In the Central Valley of California, specialized use of land for orchard and vineyard stretches almost continuously for 400 miles and, through the margins of the Delta region, links with that in the Coast Range Valleys. Separation of crop-combination regions along county boundaries is unsatisfactory, although less so than might be thought, since the civil boundaries often follow drainage courses or divides which also mark changes in use of land. The largest areas lie in the San Joaquin Valley where vast acreages of grapes are supplemented by a variety of tree crops. In each of the three included districts, a different combination of grapes occupies a different proportion of the total acreage and is accompanied by a different association of tree crops. In the smaller but more diverse Sacramento Valley and adjacent foothills, and in the Coast Range Valleys, there are an even greater variety of orchard and vineyard crop associations.

Acreages are smaller and the crop combinations somewhat simpler in the smaller, cooler valleys of the Pacific Northwest. Except in the pear-specializing Rogue River Valley, walnuts, filberts, and prunes dominate the crop-combinations of the important districts west of the Cascades. East of these mountains, apples are dominant in all areas except the Hood River Valley, with its slightly greater emphasis on pears; the Dalles district, with its sweet cherry specialty; and the Canyon district of the Middle Snake Valley. It is only in some of the smaller districts, however, that apples are not supplemented by a number of other significant orchard or vineyard crops. The Yakima Valley is not only the most important district, but also the most diversified.

UNDERSTANDING THE DISTRIBUTION OF AGRICULTURAL SPECIALTIES

Why has the distributional arrangement of orchards and vineyards assumed its present form? Why has this particular, complex, areal differentiation of crop combinations developed? It is presumptuous to assume that completely definitive answers to these or to similar "Why?" questions will be forthcoming until much careful study has been devoted to this problem in particular, and until major advances have been made in social science research in general.

Why did farmers in southwestern Michigan plant orchards in the 1870's? Why did they select peaches as the species? Why did particular growers select particular varieties, sites, spacings of trees, or years of planting for their orchards? To answer these questions would require first, a thorough knowledge of the character and qualities of the land, including climate, of southwestern Michigan in the 1870's. Secondly, it would necessitate an understanding of the numbers, character, and cultural background of the people who occupied or were occupying the area. Thirdly, it would require an accurate, detailed reconstruction of the economic, social, and political structure of the area, within its regional, national, and world setting, for the time. Knowing the complex relationships that existed among these three groups of elements, one could determine the economic activities that were available for selection. He could learn which alternative was

selected by particular individuals or groups. Finally, he could study *how* and to what degree that alternative became adopted, successful, and responsible for change in the area and its economy. But one still could not claim to know definitively *why* the mind and heart of a particular person, or those of a particular group, arrived at a given decision.

It may be charged that the difference implied by the preceding use of the words *why* and *how* is merely one of semantics, and therefore exaggerated. It is my belief, however, that it is a significant conceptual difference that is too often ignored. Had we not assumed that we could determine *why* an individual or group in society makes a particular decision, we might never have fallen into the paths of environmental determinism. Classifying as Mediterranean the agriculture of all subtropical areas having winter rain and summer drought is to imply not only that the farmers of California, peninsular Italy, and northern middle Chile have made the same decisions as to land use (which they have not), but also that we know *why* they made those decisions. We shall better understand the agriculture as we study what the actual decisions were, *how* they were made (i.e., with what relationships to what complex of conditions), and *how* they have operated.

Environmental determinism is decrepit, but determinism survives. Some would have geography become a science or vocation of prediction. Instead of studying what is in an area and how it came to be, it is urged that we predict what could, should, or will be there. It has been charged that until geographers take up the promising trade of prediction, they will continue to write for themselves alone. To predict requires knowledge of what will happen, which implies knowledge of why it will happen. But an understanding of *why* things happen in society can come only through the painstaking, almost impossible process of isolating each element of society, including man's thoughts, much as the physical scientist has isolated the elements of matter, and of learning their reactions one with another. Such progress is not likely to come through prediction unless the predictions or plans can be tested in the laboratory of reality. The practice of prediction may result in rules of thumb that make it occasionally successful and frequently profitable. But the tools and principles necessary to make it a scientific and accurate procedure can only be discovered, if indeed they can be at all, by painstaking study of what is and how it came to be. This is not to imply that geographers should not contribute to areal planning. But for all to turn to that objective would, I fear, lead us along another blind alley of determinism.

Attempts to understand the distribution patterns of agricultural land use are but one phase of the search for how ideas originate, spread, and change—the time honored task, to a degree, of many of the social sciences. The laboratory is the whole world of people, space, and time. The relationships are so numerous and complex as almost to defy isolation and measurement. We have gained some competency in measurement of space and time; we still grope in attempting to trace the source of man's ideas and the results of their application in space during time. Progress has and will come through persistent attempts to understand small segments of reality.[11]

[11] Many of us can perhaps contribute best by focusing our study on selected bits of the problem, for example, on the development and areal spread of a given type of land use. But extremely stimulating and fruitful is the scholar whose depth and breadth of understanding

(*Continued on next page*)

Scientifically to determine, *for a given time*, the areas of the United States best qualified for commercial production of a particular species and variety of fruit may be quite possible, at least to a reasonable degree of refinement and accuracy. The most basic limiting factor would appear to be temperature characteristics and sequence. Water may be transported and applied at will, as it is in some of the largest and most productive orchard and vineyard areas. Tillable soils, although they differ greatly in quality even within small areas, may be found in most parts of the country. Furthermore, they may be highly modified if other conditions warrant. Tree root development is aided by soil drainage in the Sacramento Delta, by heavy fertilization in central Florida, and by blasting of limestone in the Door Peninsula of Wisconsin. Land of usable slope is available in some quantity in all but a few sections of the country, although its character and areal arrangement within these sections differ greatly. Capital, management, or labor can be imported. Transportation costs differ but they may be borne if other conditions warrant. Plant damaging temperatures, however, can be modified only slightly even under favorable conditions; they defy effective control in most of the country.[12]

Small unit areas within those regions possessed of permissive or favorable temperature conditions could be rated on the basis of components of climate. To do so accurately would require measurement and experimentation by specialists. What, for example, are the minimum, maximum, and optimum temperatures, or temperature ranges, for the welfare of Jonathan apple trees at blossom time, at harvest time, or in midwinter? To rate each factor separately, however, would be less than satisfactory, for they operate as complexes. The effect upon an apple tree of an air temperature recorded at a given station depends not only upon the growth stage of the tree, but also upon its situation with respect to inclination and direction of slope, the nature of soil material and drainage, the effectiveness of disease and insect control, the type of tillage practiced, and the recent history of production. Once the ratings of the many separate factors, such as temperature, soils, and transport cost, were arrived at, they would need to be weighted and then combined into an overall evaluation of unit area x for the commercial production of crop x. From a multitude of tediously derived individual unit area ratings, a map could be made. Since each map would be with respect to an individual crop, or even variety, selection of a location for a diversified enterprise would require interpolation from a number of maps.

The foregoing procedure might be followed by the agricultural planning agency of a totalitarian government, or by a large corporation planning expansion of an agricultural enterprise. Being concerned with scholarship rather than with commercial enterprise or planning, I would be interested in such an investigation not in order to establish a new distribution pattern, but rather to learn how logical and stable is the

permit him to hypothesize wisely as to ultimate origins and past or future distributional developments of more complex associations of phenomena. For a most stimulating example, see Carl O. Sauer: *Agricultural Origins and Dispersals*, The American Geographical Society, New York, 1952.

[12] The limits within which air temperatures can be artificially modified over large orchard areas are narrow. Although agricultural engineers have developed useful techniques and equipment for orchard heating, the most promising approaches would seem to be judicious selection of orchard sites, careful cultural practices, and the development of varieties better adapted to the natural conditions.

current one, and perhaps to understand better how it came to be.[13]

The distribution pattern of orchards and vineyards was developed by farm operators. They did not descend upon a virgin, unoccupied America bearing commissions to find the best orchard land. For those pioneers who alone were afforded a wide choice in the selection of land, the purpose was immediate self-sufficiency and eventual saleable surplus of some of the variety of self-sufficing products. Once settlement is essentially completed, most farmers are born on the land they occupy. Theirs is not to select the best land for a given use, but to select the most profitable use for the land they have. To understand the distribution pattern of orchards and vineyards in America, then, we need to know who selected commercial orcharding as a major land use, in what areas, at what times and under what conditions. Where, when, and under what conditions did such selection prove wise and successful or unwise and temporary? It is hoped that maps now being prepared of the distribution of orchards and vineyards at earlier times will help to answer these questions, although satisfactory answers can result only from careful field studies of individual orchard and vineyard regions.[14] Pending completion of further study, the following tentative interpretation is offered.

THE BEGINNINGS OF AMERICAN ORCHARD AND VINEYARD REGIONS

Orchards are planted because of a need or desire for their product, that is, in answer to market demand. The "markets" for the earliest orchards and vineyards were the families who planted them. The earliest settlers brought seeds of the various fruits and nuts they had known in Europe: apple, pear, peach, plum, apricot, cherry, grape, almond, walnut, orange, and lemon. They were planted in "kitchen orchards" or gardens near the homes, whether isolated farmsteads, village residences, or religious establishments. Seeds were spread even in advance of the settlement frontier, carried by Indian, missionary, and trader. Products of these plantings, growing in the wilderness, often confused later arrivals as to the nature of their origin. To the nearly ubiquitous kitchen orchards were later added the slightly larger "farm orchards" which, as components of general farming enterprises, produced at least occasional surpluses for sale.

Under pioneer conditions neither the grower nor the consumer of orchard products was highly discriminating. To the farmer the orchard was a non-commercial, or at most semi-commercial, sideline. The consumer, who often was also the producer, accepted the product when and as it was available. The seedling trees grown from planted seeds produced fruits not of the original variety and often of inferior quality. Such small, unimproved orchards accompanied early settlement with relatively little regard to optimum conditions for orchard growth and production. But in the process there resulted gradual enlightenment as to those growth conditions, a fact of great importance to the later rearrangement of areal distribution and to the efforts toward improvement of varieties to fit the conditions and needs of particular areas. The direction and extent

[13] Again, this is not to imply that the geographer should not offer his skill for purposes of evaluation and prediction, as the geologist, meteorologist, or economist does. But it is regrettable if a so-called geographer assumes that his training enables him to make evaluations or predictions based upon the synthesis of complex phenomena he knows little about.

[14] See the studies of individual regions mentioned in Footnote 6.

of spread of kitchen or farm orchards, or of their individual species, depended upon three sets of factors: (1) the growth habits of the species in relation to the climatic and soil conditions of the area, including local modifications of climate due to land form or surface material; (2) the ability of the species to resist disease or pests, the prevalence of which may also be related to climatic conditions; and (3) the needs, desires, abilities, and whims of the settlers.

Climate: Poleward Limits

In America, as in Europe from which the seeds were transported, the poleward limits of the various fruits and nuts were and are a function of their abilities to derive sufficient intensity and duration of heat in summer for proper growth and maturity, and to withstand the minimum temperatures of winter. In northwestern Europe with its cool summers and mild winters the former quality is more critical; in eastern America with its more extreme temperatures in both seasons, cold winters are the greater hazard.[15] Many varieties of the peach could endure the minimum temperatures of the lowland Scottish winter; they can not, however, grow and mature satisfactorily in the limited warmth of summers there, or even in northwestern, maritime France. In the continental climate of eastern America, the relationships are reversed. Peaches may find sufficient summer warmth in western Minnesota but their production there, or even in northern Illinois, is rendered extremely hazardous by the usual minimum temperatures of winter. The seasons, of course, operate in combination. The degree of danger from a given low winter temperature is related to the health status of the tree, including the degree to which its wood has "hardened," which is in turn partially a result of conditions for growth during the preceding summer.

Hardiest with respect to minimum temperatures in winter and limited warmth in summer are the trees of the apple. Some varieties such as Oldenburg (Duchess), of eastern European origin, or the McIntosh, developed in Canada from the French introduced Fameuse (Snow), may survive temperatures of −40°F. Varieties of average hardiness may withstand −30°F. under ordinary conditions, although tender ones such as Baldwin or Gravenstein would likely suffer serious injury from such temperatures.[16] Although steady winter temperatures are more desirable than highly fluctuating ones, prolonged subzero cold may result in freezing of soil to such depths as to severely injure the tree roots.

Apple fruit buds (and thus the next year's crop) are more susceptible to winter injury than the wood of the apple tree. The latter is not easily injured once it has sufficiently matured or "hardened" following the growing season. Insufficient hardening may result from poor tree health or from late growth required by a short growing season or stimulated by heavy soils or by cultural practices such as prolonged cultivation or late pruning. A combination of late summer growth and early winter cold may be disastrous. So too may sudden cold following a period of mild temperatures in late winter, during which flow of sap and swelling of buds may have been stimulated. A unique kind of damage from suddenly falling temperatures is known as winter sun scald. On a still, clear, cold winter

[15] See J. Russell Smith: *The World's Food Resources*, Henry Holt and Company, New York, 1919, Chapter 18.

[16] William H. Chandler: *Deciduous Orchards*, Philadelphia, 1947, pp. 120–122; Gardner, Bradford and Hooker: *The Fundamentals of Fruit Production*, New York, 1922, pp. 250–336.

afternoon, the sun's rays may strike the southwest side of a tree trunk and adjacent lower limbs at an angle near ninety degrees. The dark colored bark, and tissues underneath, may absorb sufficient insolation to thaw, even though the air temperature be near 0°F. When the sun disappears the temperature of the thawed bark drops almost instantly to that of the surrounding air. Killing of tissue and eventual splitting of bark, frequently results. The danger is imminent in early winter, since wood at the crotch and base of the tree trunk is the last to reach winter maturity or peak hardiness.

Winter cloudiness, such as is common along the leeward sides of the Great Lakes, may reduce the danger of this and other types of winter damage. The generally modified temperatures and greater snow cover of these shore areas are likewise significant. It may be generalized that the various winter temperature relationships in eastern Anglo-America tend to limit commercial cultivation of the apple, hardiest of the fruits, to areas near or southward from the Great Lakes–St. Lawrence region.

The red tart or sour cherry tree (Prunus cerasus L.) is about as resistant to low winter temperatures as medium hardy varieties of apple. Two factors help to account for its much more restricted distribution, both in the pioneer orchards of the last century and in the commercial orchard industry of the present. The diffusion of both sweet and red tart cherries was retarded in early times because the seeds were to a large extent nonviable. Development of new and more widely adapted varieties has no doubt been retarded by the same factor.[17] Present distribution of commercial production of red tart cherries is much more restricted than that of apples, partially because cherry trees flower early in spring and are highly susceptible to spring frost damage.

With its great desirability, its high viability from seed, and its quick growth to bearing age, the peach accompanied the pioneer settler almost as far and widely as the apple. But the peach suffered far more severely from the southward invasions of cold air during winter in the northern Great Plains, the Midwest, and southern Canada. Dormant peach wood, as well as buds, may be severely injured by a temperature of −15°F., especially if the temperature drop is sudden and considerable. Temperatures as low as −20°F. are likely to be injurious at any time, recognizing, of course, that extent of injury varies with a number of interrelated factors including variety of tree, its age and health, the orchard site, the sequence of temperatures within which the minimum is included, and the management practices both before and after injury.

Pear, plum, and sweet cherry trees, although they differ greatly by species and variety, are intermediate between the average peach and the average apple in winter hardiness. The poleward limits of all are more restricted than those of the apple, although generally less than those of the peach.

The Old World grape (Vitus vinifera L.), the apricot, and the almond were all introduced into the eastern United States, but with little success. Lack of resistance to winter injury contributed to the failure of each, especially in the northern areas. After much experimentation, varieties of grapes better adapted to eastern United States were developed from native American species, or from their hybrids with

[17] F. P. Cullinan: "Improvement of Stone Fruits," in *Yearbook of Agriculture, 1937*, U. S. Department of Agriculture, Washington, D. C., 1937, pp. 665–748.

vinifera. Their poleward limit is related more to length and effectiveness of growing season than to winter temperatures, although their resistance to the latter is no greater than that of medium hardy apples.

Neither of the two nut crops produced commercially in the South was introduced by early settlers. The pecan, a species of hickory, is indigenous. Although selection and improvement of varieties was begun in mid-nineteenth century, commercial production of improved varieties dates from about 1920 and still accounts ordinarily for only about half the total commercial production.[18] The range of the undomesticated pecan reaches into the Ohio Valley, but dependable nut production is limited to more southerly areas with a 200-day growing season. The tung tree was introduced into the United States from China in 1905 and was neither improved nor cultivated widely until the last three decades. Knowledge of its growth habits with respect to environmental conditions is still limited, although it seems clearly restricted by winter injury hazard to the southern margins of the country.

The poleward limits for dependable production from the evergreen citrus trees lie, also, just within the southern margins of the United States. Although citrus trees seem to require some cool weather for proper development and production, experiments indicate that growth occurs only when temperatures are in the neighborhood of 55°F. or higher.[19] In the United States, average January temperature is above 55°F. only in the Florida Peninsula, the outer Mississippi Delta, and in southernmost Texas.[20] These areas, along with the Southwest, are likewise the only parts of the country infrequently invaded by citrus-killing air temperatures in winter. Sweet orange, grapefruit, and tangerine trees are likely to be injured by temperatures lower than 23°F., lemons by 26 or 27°F., and limes by 28°. Fruits of any of the citrus trees may not withstand 28°F.[21]

Equatorward Limits

There are equatorward as well as poleward limits for optimum growth and production of the deciduous hardy fruits and nuts. Equatorward limits are related primarily to maximum temperatures during winter, spring, and summer.

Red tart cherries appear to be most restricted by high summer temperatures. They thrive best where mean monthly temperatures during June, July, and August are about 65°F.[22] Although varieties of apple differ greatly, most seem best adapted to mean summer temperatures of 55 to 75°F. Most commercially important plums (Prunus domestica L.) also require relatively cool growing season temperatures. Those grown in the South are mostly of relatively inferior varieties of native American origin (Prunus americana Marsh). Pear production in the South is likewise from relatively inferior varieties developed

[18] However, most of the production in the pecan orchard regions of southwestern Georgia and near Mobile Bay is from improved varieties. Production from wild or seedling varieties is primarily from Texas, Oklahoma, Louisiana, and Arkansas where the native trees grow along stream courses.

[19] J. R. Magness and H. P. Traub: "Climatic Adaptation of Fruit and Nut Crops," in *Climate and Man*, Yearbook of Agriculture, 1941, U. S. Department of Agriculture, Washington, D. C., 1941, pp. 400–420. See also Edward A. Ackerman: "Influences of Climate on the Cultivation of Citrus Fruits," *Geogr. Rev.*, Vol. 28, 1938, pp. 289–302.

[20] J. B. Kincer: "Climate and Weather Data for the United States," in *Climate and Man*, *op. cit.*, p. 704.

[21] J. R. Magness and H. P. Traub, *op. cit.*, p. 402.

[22] *Ibid.*, p. 410.

from the Chinese or sand pear (Pyrus serotina Rehd.). Commercial production of the more desirable varieties of the European pear (Pyrus communis L.) is limited to more northerly or western areas with less hot and humid growing seasons. Of the commercially grown hardy tree fruits, the peach is best adapted to high summer temperatures, partially because it matures early. Even it, however, does not do well under true subtropical summer conditions. The commercially important varieties of American grapes require a long growing season but are ill adapted to one with high temperatures and humidity.

Equally critical in establishing equatorward limits of the deciduous hardy fruits are the high temperatures, or, conversely, the lack of low temperatures, in winter. The leaf and flower (fruit) buds of the deciduous fruits form in summer a year or more prior to the summer in which they grow. Soon after formation they enter a rest period. They do not open, even though autumn conditions be excellent for growth. Nor will they open properly in spring unless the rest period be broken by a given amount of chilling.[23] Fruit buds usually require slightly less chilling than leaf buds. If, because of too little chilling, fruit buds break into bloom while leaf buds are still retarded, the fruit fails to set owing to lack of food supply from the leaves.

Most varieties of apples require from 900 to 1000 hours with temperatures below 45°F. fully to break the rest period. This fact, together with their apparent preference for mean monthly temperatures below 75°F. in summer, limits major production to highland or northern sections of the country. The chilling requirement of most peach varieties is satisfied by 600 to 900 hours below 45°F. This, with their greater tolerance of high summer temperatures, permits dependable production much farther south. As with adaptation to summer temperatures, most pears, plums, and sweet cherries have chilling requirements intermediate between the apple and peach.

[23] Chandler, *op. cit.*, pp. 54–61.

Spring Frost Hazard

Within that area in which the usual minimum and maximum temperatures are permissive for the satisfactory growth of a given species of fruit or nut tree, production from the species is, to a significant degree, directly related to the ability of its fruiting mechanism to resist spring frosts. Suffering from high summer temperatures may be lessened by moving poleward, or danger from winter injury by a retreat equatorward. There is no such escape from the spring frost hazard unless the orchardist move out of the United States and into the tropics where no frosts occur.

Spring frosts are here defined as killing temperatures which occur during the transition from the cold to the warm season. They may and do occur in February in Florida and southern California, in March or April in Georgia and Virginia, and in April or May in the Great Lakes area. The susceptibility to spring frost injury of a given tree or vine crop depends upon its natural time and duration of flower and fruit formation, the natural resistance of its flowers and young fruits to cold, and the modification of these by the particular environmental and cultural (orchard management) conditions. Most significant of these is the time and duration of flowering, both because there is greater variation among species and varieties in this respect than in the resistance of their flowers or fruits to cold, and because it is this characteristic

which is most influenced by variable, local environmental and cultural conditions.

Most apples and American grapes are among the latest of the deciduous fruits to bloom and, consequently, are least susceptible, although by no means immune, to crop reduction by spring frosts. Among the earliest to bloom are the fig, apricot, almond, and filbert, none of which is grown on a large scale in eastern United States where late season, as well as unbearable midwinter, invasions of cold air are common. The sweet cherry, peach, and many varieties of plum bloom a little later; their crops are often reduced by late frosts. Red tart cherry flowers open still later, just before many apples, but, since their young fruits develop rapidly and remain tender for several weeks, they too are highly susceptible to spring frost injury.

The spring frost hazard is intricately related to winter temperatures and the chilling requirement. Inadequate chilling may result in delayed and straggling flowering of peach trees, especially in Georgia and the Carolinas. This in itself is unfortunate—it may result in reduction of crop through poor setting of fruit. But the delay in flowering may be little enough not to interfere significantly with fruit setting, and yet great enough to provide escape from a late frost that could wipe out the crop. Such a frost on March 26–27, 1955, is reported to have destroyed the entire peach and most of the pecan and tung crops in and southward from the Ozarks, southern Illinois, and southern Virginia.

Within the areal limits set by seasonal temperatures, orchard and vineyard crops advanced westward with settlement from the Atlantic coast. Some, such as citrus fruits, were restricted to the extreme southern margins of the country. Others, such as European varieties of apple, cherry, pear, and plum, were discouraged in the lowlands of the South by high temperatures of winter, spring, and summer, sometimes through the action of fungus or bacterial diseases which flourished in the warm, humid air. Still others, such as the fig, apricot, almond, filbert, walnut (Juglans regia, L., introduced from Europe), olive, and European grape, found suitable growing conditions nowhere in eastern America. The hardy apple was spread from Canada to the Southern highlands; the less hardy but popular peach from the deep South almost to the northern borders. These, together with fewer numbers of pears, plums, and American grapes, comprised the kitchen and farm orchards which, by 1850, were being planted beyond the Mississippi.

Beginnings and Spread in the West

In the eastern margins of the Great Plains, beyond the lower Missouri, orchard and vineyard species met a new barrier—aridity. Equal aridity combined with milder temperatures might have permitted further penetration. But the frequent, hot droughts of summer, as well as the drying winds accompanying the invasions of extremely cold air in winter, made orchard and vine production undependable, if not impossible.

Crossing the unclaimed plains, the pioneers planted their settlements—with fruit trees and vines—beyond the Wasatch, Cascades, and Sierra Nevada. But here were different environments to be evaluated and an additional source of planting stock and experience to be drawn upon—the Spanish settlements of California and the Southwest.[24]

Into these settlements the mission fathers had introduced all of the fruits which had proved successful in the East

plus many which had not: the European grape, olive, fig, apricot, date, almond, and walnut. The Spanish introductions were long confined mainly to the gardens of the missions, presidios, pueblos, and ranches of southern and coastal California. Most California farms were established by westward moving Americans who, as elsewhere, planted kitchen and farm orchards primarily with apple and peach trees, secondarily with pear, plums, and cherries, all brought from the East. They began to add, however, from the greater variety of fruits and nuts growing in the Spanish settlements.

Assuming an adequate supply of moisture from precipitation or irrigation, a greater variety of species was permitted by the milder temperatures of the Far West. January temperatures were found to average above 44°F. throughout the lowlands of California and well above freezing in the valleys west of the Cascades, a condition confined in the eastern part of the country to the Cotton Belt and southward. But, more important, the western valleys were less subject to the alternating extremes of high and low temperatures common to winters in the Southeast, especially to the cold air masses which frequently sweep southward and eastward out of the northern interior of the continent crushing attempts in the East to grow such tender crops as figs, walnuts, or filberts or such early flowering ones as apricots or almonds. The average annual minimum temperatures of 25°F. or higher in the California valleys are equalled in the eastern United States only in the Florida Peninsula and extreme southern Texas. In the valleys west of the Cascades the average annual minimum is above 10°F., equalled in the South only in the coastal plain, southern Piedmont, and lower Mississippi Valley.[25]

Such a winter regime of temperatures permits the growing of citrus fruits in the southern lowlands and even in the Sacramento Valley of California. The fig, olive, almond, and European grape mature throughout the area of Mediterranean climate. The walnut, filbert sweet cherry, and apricot thrive in mountain-enclosed valleys almost to the Canadian border. The hardier peach, plum, pear, apple, and American grape face less winter temperature hazard in many Cascade and Rocky Mountain valleys than in most parts of the eastern United States.

In California the high temperatures of winter and summer are as much to be reckoned with as the low temperatures of winter. Although they carefully evaluated local climates and selected orchard crops accordingly, growers did not understand until recent decades why almonds, apricots, peaches, or plums, for example, were frequently delayed or straggling in their blooming in southern or even central California areas. It was finally discovered that in such cases winter chilling had not been sufficient to break the rest period of the naturally deciduous trees.[26] A moderate delay might benefit through escape from a late spring frost. But long delay or unevenness in development of flowers and leaves may result not only in loss of crop but also in damage to trees. High summer temperatures, on the other hand, restrict commercial production of apples, red tart cherries, pears, and plums to cooler coastal or more elevated areas.

In the western as in the eastern

[24] A third source was the orchard and vineyard planted by Russian settlers near Fort Ross and containing apple, peach, pear, quince, and cherry trees and a few vines. See Claude B. Hutchison, edit., *California Agriculture*, Berkeley, 1946, p. 22 and Plate VII.

[25] Kincer, *op. cit.*, pp. 685–1210.

[26] Claude B. Hutchison, edit., *California Agriculture, op. cit.*, p. 194.

United States, danger from spring frosts is everywhere present. If the category include all frosts during the transition from winter to summer conditions, it is the chief cause of crop loss. Mid-winter temperatures low enough to injure dormant deciduous orchards and vineyards are relatively rare. But once the chilling requirements have been met and the rest periods broken, mild weather may encourage initiation of bud growth and consequent loss of resistance to cold. Trees of almond or apricot may begin to blossom before the end of January. Under such conditions, extreme radiation cooling during night time may be disastrous.

Disease and Pests

The relationship between climatic conditions and the spread of orchard and vineyard species and varieties in Anglo-America has been significant, direct, and complex—much more complex than the foregoing brief discussion has been able to suggest. The same relationship, as expressed indirectly through the incidence of disease and pests, has likewise been significant and complex. The following example may be illustrative.

Pear trees, of European seed (Pyrus communis L.), grew in the early kitchen orchards of English, French, and Spanish colonists in eastern America. Before the end of the eighteenth century a disease called fire blight or pear blight began to destroy the trees. Although its cause, a bacterium working in bark tissues, was not discovered until a century later, it has been epidemic in the humid eastern United States since colonial times, attacking all desirable varieties of European origin. The disease, for which no real cure has been found, apparently is encouraged by the warm, humid weather of the East, especially by a warm, moist spring that results in rapid tree growth. Only in areas where spring and summer weather are relatively cool, such as along the shores of the Great Lakes, has the commercial production of European variety pears been successful in the eastern United States. Minor production elsewhere in the East has been largely of less desirable varieties, such as Kieffer, developed by crossing the European with the inferior Chinese or sand pear (Pyrus serotina, Rehd.).[27] Thus American pear production is about five-sixths in summer-dry valleys near the Pacific Coast, a fact due in considerable part to a climatic relationship expressed indirectly through a bacterial disease.

Codling moth and apple scab, the two worst pests for apple growers, are favored by early growing seasons which are hot and dry or cool and moist, respectively. Such indirect climatic relationships have considerable significance in the distribution of a highly competitive industry.

Plant Breeding

Fruit and nut seeds and seedlings transported to America from northwestern and Mediterranean Europe found growing conditions most satisfactory, in general, in the cool-summer, humid Northeast and Northwest and, if watered, in the dry-summer West. For all the trees and vines, conditions were least tolerable in the cold-winter, dry Great Plains; many were ill-adapted to the early spring and hot, humid summer of the Southeast.

But these were not wild plants. Their domestications are lost in antiquity. Through selection and care by man, they had undergone vast modification before reaching Europe from the lands beyond

[27] *Yearbook of Agriculture, 1937*, U. S. Department of Agriculture, Washington, D. C., pp. 616–618.

the eastern Mediterranean, some from as far as China.[28] Further care resulted in the development of numerous improved varieties of the various species in Europe. It was these improved varieties, or seeds or seedlings therefrom, which were brought to America.

Most of the early kitchen orchards consisted of seedling trees. Since most fruit and nut species do not come true from seed, wide variations in size, color, and quality of fruit and in season of ripening were common. Settlers soon began to select the most desirable trees from their kitchen and farm orchards and to establish and develop these as new varieties by grafting cuttings from them upon hardy rootstocks.[29] During the eighteenth and nineteenth centuries, hundreds of new varieties were developed in this way from selected chance seedlings. Included are most of the currently important commercial varieties of apple, peach, sweet cherry, American grape, almond, pecan, lemon, and grapefruit. The leading commercial varieties of pear, plum, red tart cherry, apricot, European grape, and walnut were developed earlier in Europe by similar selection.[30]

The selection and improvement of fruit and nut varieties have been a significant factor in development of the distributional arrangement of orchards and vineyards. On the one hand, through increasing the resistance of trees or vines to climatic or disease hazards, it has permitted dispersion. But since selection has been dominated by the specially interested, for purposes of meeting specific needs in particular areas, the much more important tendency has been toward localization. This tendency is strengthened by the considerable efforts of the past half century to *produce* (as contrasted with earlier efforts to discover) new and better varieties. These efforts carried out mainly by federal and state research agencies and by private nurseries, involve the production of hybrid varieties that will possess particular desired characteristics of the parents. Results are slow because of the slow-growing and delayed-bearing characteristics of the plants involved. An example is the development in southwestern Michigan of the Halehaven, Kalhaven, and Redhaven peach varieties to meet the particular climatic and marketing conditions of that area.[31]

COMMERCIALIZATION-SPECIALIZATION-LOCALIZATION: THE EMERGENCE OF ORCHARD REGIONS IN THE EAST

Three conditions were necessary for the development of orchard and vineyard regions: (1) a market demand for the product, (2) a permissive, if not favorable, natural environment, and (3) recognition of the opportunity afforded by these conditions and the desire and ability to profit therefrom. In the early days of small, widespread kitchen and farm orchards, the market was correspondingly small and widespread; environmental conditions were not carefully evaluated. Then came the change which has stimulated the revolution in agriculture in America and the world—the multiplication and alteration of market demand.

Urbanization separated most householders from their kitchen orchards, as

[28] For plant origins see Sauer, Chandler, or *Yearbook of Agriculture, 1937, op. cit.*

[29] Most fruit and nut trees are now propagated by budding, that is, by grafting a bud (scion) of the desired variety to a hardy rootstock and, when dormancy ceases, removing the stock above the bud so that the latter becomes the tree.

[30] *Yearbook of Agriculture, 1937, op. cit.*, pp. 575–889.

[31] Largely under the leadership of Stanley Johnston at the South Haven Experiment Station.

from their milk cows and vegetable gardens. Increase of population, especially in cities, multiplied demand for the product of farm orchards. As farm orchards were expanded to meet the demand for quantity, they became subject to new demands—for quality. Only those growers who took advantage of the new developments in plant improvement, pest control, pruning, thinning, tillage, fertilization, harvesting, and selling, could survive the competition that ensued.

Specialization resulted. The farmer with three or four acres of orchard and the remainder of his 80 acres devoted to field crops and livestock does not postpone corn-planting in order to spray apples, or interrupt haying so as to thin peaches. Unsprayed apples and unthinned peaches lost out in the increasingly quality-conscious market. Thus, the general farmer faced the alternatives of expanding and intensifying his farm orchard enterprise, or of abandoning it. Most were abandoned. Where the first alternative, specialization, was chosen, orchard regions began to emerge. The evolution occurred where one or a combination of three sets of conditions existed: (1) advantageous location with respect to market, (2) advantage with respect to natural growing conditions, especially climate, and (3) a particular desire to specialize in orchard or vineyard enterprise.

Market Advantage

Obvious convenience to large markets is enjoyed by the major orchard districts of southern New England, central and southern New Jersey, northeastern Ohio, and southeastern and southwestern Michigan. Since the three sets of conditions most often operate in combination, the market advantage of other orchard regions is less obvious. Among those parts of the world where the temperature regime permits dependable citrus production, the Florida citrus districts are closest to the great markets of northeastern United States and southeastern Canada. Before the great freeze of 1894–95, their distance to major markets was slightly shorter but their situation with respect to climate and landforms was less favorable than now.[32] The apple districts in northwestern Arkansas, southern Illinois, and the southern Blue Ridge are, within climatically permissible areas, closest to the limited but significant southern markets. Among eastern peach-growing regions, the Georgia districts are among the farthest from New York or Philadelphia, yet they are the first able to place fresh peaches in those markets. During late August, the Grand River Valley of Colorado usually holds an advantage in the Chicago peach market—the peaches of Georgia, Arkansas, and southern Illinois are gone; the major harvest in southwestern Michigan has not yet begun. If man is to be charged with adaptation to his environment, let him be credited, not with blind submission, but with surprisingly effective evaluation and selection from among alternative uses of land.

Climatic Advantage

Within the permissive climatic limits that have been briefly generalized, there are conditions which impart advantages to certain areas. Chief among these are the ameliorating effects upon climatic hazards of water bodies and hills or highlands.

The largest-scale moderation of climatic extremes is, of course, that performed by air moving from the Pacific Ocean onto the adjacent west coast lands. The consequent absence of low

[32] See Warren Strain: "The Florida Citrus Crop," *Econ. Geog.*, Vol. 18, 1942, pp. 17–28.

winter temperatures and, near the coast, extreme summer temperatures, contributes toward the favorable conditions for a great diversity of fruit and nut crops. The Pacific coast's locational relationship to the great markets of eastern America is usually thought of as unfavorable. For selling late potatoes or fluid milk it is; but for selling European grapes, figs, apricots, olives, almonds, filberts, and walnuts, it is the best on the continent.

Florida's peninsular position also results in maritime moderation of climatic extremes. The hurricane hazard has proven less damaging to citrus production than would the low winter and spring temperatures farther inland and northward. It is not without significance that the west coast and Florida, with their maritime moderation of temperatures, have the greatest and most rapidly expanding acreages of orchards and vineyards in North America.

The Great Lakes lie in the interior of the continent across the usual path of the great masses of cold air that frequently surge southward and eastward from the northern Great Plains and Mackenzie Basin. The relatively warm, unfrozen waters, especially of the four more southerly lakes, raise temperatures in the lower layers of such air so that orchards and vineyards along the leeward shores are subjected to less extreme low winter temperatures than are common on the opposite sides of the lakes. The average annual minimum temperature on the eastern side of Lake Michigan is about 10°F. higher than on the western side. Temperatures of −20°F. may occur about one year in four in the Lake Michigan coastal area south of Milwaukee; on the opposite shore they have occurred about one year in 20.[33] The fruit buds and even the wood of peach, sweet cherry, plum, pear, and some apple trees are liable to severe damage from such temperatures.

In spring the slowly warming waters of the Great Lakes cool the air which moves off their surfaces toward the more rapidly warming land. Opening of the delicate blossoms and formation of the tender young fruits is delayed. Such temperature lag and retarding of plant growth occurs along all shores of the Lakes.[34] Blossom activity is not delayed until all danger of frost is past, as is sometimes stated. Spring frosts do occur and, apparently, even slightly later, on the average, along the immediate eastern than along the western shore of Lake Michigan. But when the late winter-type storm brings a mass of dangerously cold air southward and eastward, it must cross the relatively warm lake waters before enveloping orchards and vineyards along the eastern and southern shores.

The air-warming apparatus of the Great Lakes in winter becomes an air-cooling system for the coastal areas in summer. The effect includes both lowered temperatures near the lakes and increased circulation of air between adjacent land and water surfaces. Both are of some benefit in combatting bacterial fungus diseases such as pear blight or black-rot of grapes. Moderation of high temperatures is also helpful, sometimes essential, to proper ripening and harvest of most hardy fruits, and to control of certain diseases and pests, such as codling moth.

Smaller water bodies exert lesser but significant effects. These include Green Bay, the Finger Lakes of New York,

[33] Clarence W. Olmstead: *The Pattern of Orchards in Michigan*, Ph.D. dissertation, University of Michigan, 1951.

[34] *Ibid.* See also John Leighly: "Effects of the Great Lakes on the Annual March of Temperature in Their Vicinity," *Papers of the Michigan Academy of Science, Arts and Letters*, Vol. 27, 1941, pp. 377–414.

Great Salt Lake, and the countless lakes which dot the citrus areas of Florida.

Hills or highlands also modify local climates in ways significant to tree and vine crops. One effect is that of the protective barrier. The Rocky Mountains form a first and the Cascades and Sierra Nevada a second barrier to the invasion of west coast orchard and vineyard regions by cold, continental air in winter. Although such air masses move generally eastward rather than westward, they would, but for the mountain barriers, occasionally overspread and injure, near the west coast, species which are precluded by low temperatures from similar latitudes in the eastern United States.

Aside from the great areas lying west of the Cascades and Sierra Nevada, most of the orchard districts of the West lie in valleys protected by adjacent mountains. Examples are the Yakima, Wenatchee, Chelan, Okanogan, Middle Snake, Wasatch, Grand River, and Salt River Valleys. It is significant that the American citrus region to suffer most severe and frequent crop and tree damage during the last decade, the Lower Rio Grande Valley, is the region nearest the equator but the one lacking major benefit of either maritime or landform protection from southward invasions of cold, continental air.

Aside from the Far West, Florida, and the Great Lakes realm, the largest acreages of orchards in the United States are in the Appalachians. Almost all lie either in mountain enclosed valleys or at the eastern, leeward base of the Blue Ridge. Valley locations include not only those within the area mapped as the Appalachian realm, but also the Hudson Valley. Leeward piedmont locations include also the Spartanburg peach area and, to a lesser degree, the peach districts of central Georgia.

Both peach districts of the Ozark-Ouachita realm are protected by highland barriers to the northward. The Clarksville district lies on south-facing slopes below the Boston Mountain upland. The low ridge whose south-facing slopes bear most orchards of the Nashville district is protected from cold north winds by the higher east-west ridges of the Ouachita Mountains. The most northerly of the important apple districts in the eastern United States unprotected by a body of water is the Hillsborough district in New Hampshire. It lies south and east of a 2000-foot monadnock ridge.

Land Type[35]

The land type most favorable for orchards or vineyards is one with perceptible but moderate slope toward a lower surface, and with deep, well-drained soils of moderate fertility. Well-drained soils, even though sandy or gravelly, are necessary for the growth of deep-rooted orchard trees and vines. Slope toward a lower surface facilitates air drainage and consequent reduction of low-temperature hazard. During a period of strong, cold winds, such as often occur along a cold front, a high, exposed orchard site is unfavorable. Position leeward from a mountain barrier or water body may offer valuable protection, both from cold winds and, in the case of the mountain barrier, through adiabatic heating of descending air. But most freezing damage, either

[35] For origin and development of the land type concept, so useful in the study of agricultural use of land, see J. O. Veatch: "Natural Geographic Divisions of the Land," *Papers of the Michigan Academy of Science, Arts and Letters*, Vol. 16, 1930, pp. 417–432; "Classification of Land on a Geographic Basis," *ibid.*, Vol. 19, 1933, pp. 359–365; "The Idea of the Natural Land Type," *Proceedings of the Soil Science Society of America*, Vol. 2, 1937, pp. 499–503.

in winter or spring, is caused by the minimum, night-time temperatures that occur during the calm, cold weather following the passage of a cold front. Under such conditions, a sloping site adjacent to a lower surface permits the heavier, colder air to flow down and out of the orchard. Although red tart cherry and peach orchards have been observed in which spring frost injury was greatest in the most exposed portions of orchard or trees, it is much more common, at least in the Great Lakes realm, to note the greater damage in low areas, especially in drainage pockets. Occasionally, there is a sharply defined horizontal plane separating the severely damaged from the little damaged blossoms or fruits in an orchard.

In the empirical development of specialized, areally differentiated agriculture, the farmer with sandy or gravelly soils on moderate to steep slopes found himself at a disadvantage in growing corn, small grains, hay, and cotton. But in considering alternatives he learned that, other factors permitting, his land was superior to the rich bottomlands or prairies for the production of fruits and nuts.

Almost without exception, orchard and vineyard areas in the eastern United States are comprised of sloping sites adjacent to lower surfaces and possessed of well-drained, relatively light-textured, usually sandy or gravelly soils. No significant area departs from both the landform and soil characteristics. In the Great Lakes realm, the Door Peninsula area is on a cuesta ridge of Niagara limestone sloping steeply to Green Bay and gently to Lake Michigan. The soils are shallow but well-drained. The Western Michigan districts occupy moraines or elevated till plains that overlook lower surfaces of glacial till, outwash or water. The well-drained Onaway, Emmett, Hillsdale, and Miami sandy loams on the smoother surfaces of these small uplands are first class orchard soils but less suitable for field crops. The southeastern Michigan districts likewise occupy an elevated, morainic belt, the nearest such area to the great Detroit market. Most other Great Lakes orchard and vineyard districts occupy a plain which, although fairly smooth, slopes toward the lower lake surfaces. Old beach ridges, whose sandy or gravelly soils stand above the plain, are coveted for orchard sites. In the Finger Lakes area, vineyard sites slope from the gently rolling glaciated upland to the lake surfaces as much as a thousand feet lower.

All orchard and vineyard areas in the Appalachians, the Hudson Valley, and New England are comprised largely of land types whose elevation, relief, and soils provide generally adequate soil and air drainage and soil fertility for orchards, but whose use for more general field crop farming has been proven questionable. The core area, in terms of location, acreage, and production, is the Middle Appalachian Ridges and Valleys. In the Pennsylvania-Maryland district, the orchards are primarily on the eastern and western lower slopes of the Blue Ridge and, secondarily, on the lower slopes of North Mountain westward across the Cumberland Valley. Farther southwestward, in West Virginia and Virginia, extensive orchards occupy the slopes of axial ridges and rolling lands rising from the rough floor of the Great Appalachian Valley. In the Upper Potomac district to the westward, the usual orchard site is on the lower slopes of high ridges or on the crests of lower parallel ones. One such orchard west of Hancock, Maryland, extends continuously for more than six miles along the southeastward-facing slope of

Tonoloway Ridge from which it overlooks the Potomac as much as 700 feet below. Eastward across the Blue Ridge from the Great Valley, the Piedmont orchard districts of central and northern Virginia occupy the lower eastern slopes and foothills of the Blue Ridge, the counterpart of the Eastern Blue Ridge locality of Pennsylvania farther north. Farther southwestward, the smaller orchard areas of southern Virginia and highland North Carolina and Georgia are comprised of irregular patches of orchard tucked in hilly mountain valleys or perched on sloping benches, often surrounded by non-agricultural, wooded lands.

The orchards of the Hudson Valley, protected by the Catskills and conveniently near the great metropolitan New York market, occupy lands so rough that the only major competitive, agricultural use is grassland farming. Most New England orchards likewise occupy hilly, stony lands most of whose area has reverted to woodland despite the nearness to large markets.

On the coastal plains of New Jersey and Delaware the orchard areas are of lower elevation and lesser relief, although only those of Delaware approach flatness. All, however, have deep, sandy soils. The peach districts of the Carolinas and Georgia lie along the sand-hill belt at the inner edge of the coastal plain or on relatively rough and sandy sections of the Piedmont. Even along the Gulf coast and in Florida, only the Lower Rio Grande Valley, the Mississippi Delta, and the Indian River, Southeast Coast, and South Gulf Coast districts of Florida provide less than 50 feet of local relief within mile-square units. In the Ridge district of central Florida, citrus groves extend almost continuously for 60 miles along a narrow, sandy ridge whose crest stands a scarce but significant 50 to 200 feet above the lake-dotted, wet lands on either side. Elsewhere in central Florida, the large and increasing acreages of highly productive orchard occupy droughty, sandy lands that rise in low, gentle swells above the surrounding lakes and swamps. Although virtually no alternative agricultural use for these lands is known, a unique combination of diet, technology, and economic system has rendered them among the most valuable farm lands in America.

In the Ozark-Ouachita realm, the Clarksville and Nashville orchard districts lie on the lower, southern slopes and foothills of the Boston Mountains and Ouachita ridges, respectively. Soils are mainly of the sandy Orangeburg and Hanceville series. In northwestern Arkansas ridge crests and gently rolling uplands provide sites from 100 to 300 feet above the White River Valley. All orchard districts of the Mississippi Valley except the Drift Plains possess relatively great local relief. The most important ones are highly dissected by adjacent streams, as in the case of Calhoun County, Illinois, or occupy elevated rough lands such as the Ozark Ridge of southern Illinois.

Management and Organization as Factors in Localization

Relative advantage with respect to markets, climatic hazards, and land types does not create specialized orchard and vineyard regions. The opportunities must be recognized and developed by farmers.

Successful development and maintenance of a regional orchard and vineyard specialty requires the expert attention of many people, not only farmers but also processors, packers, brokers, shippers, researchers, inspectors, laborers, labor recruiters, bankers, and handlers of equipment and sup-

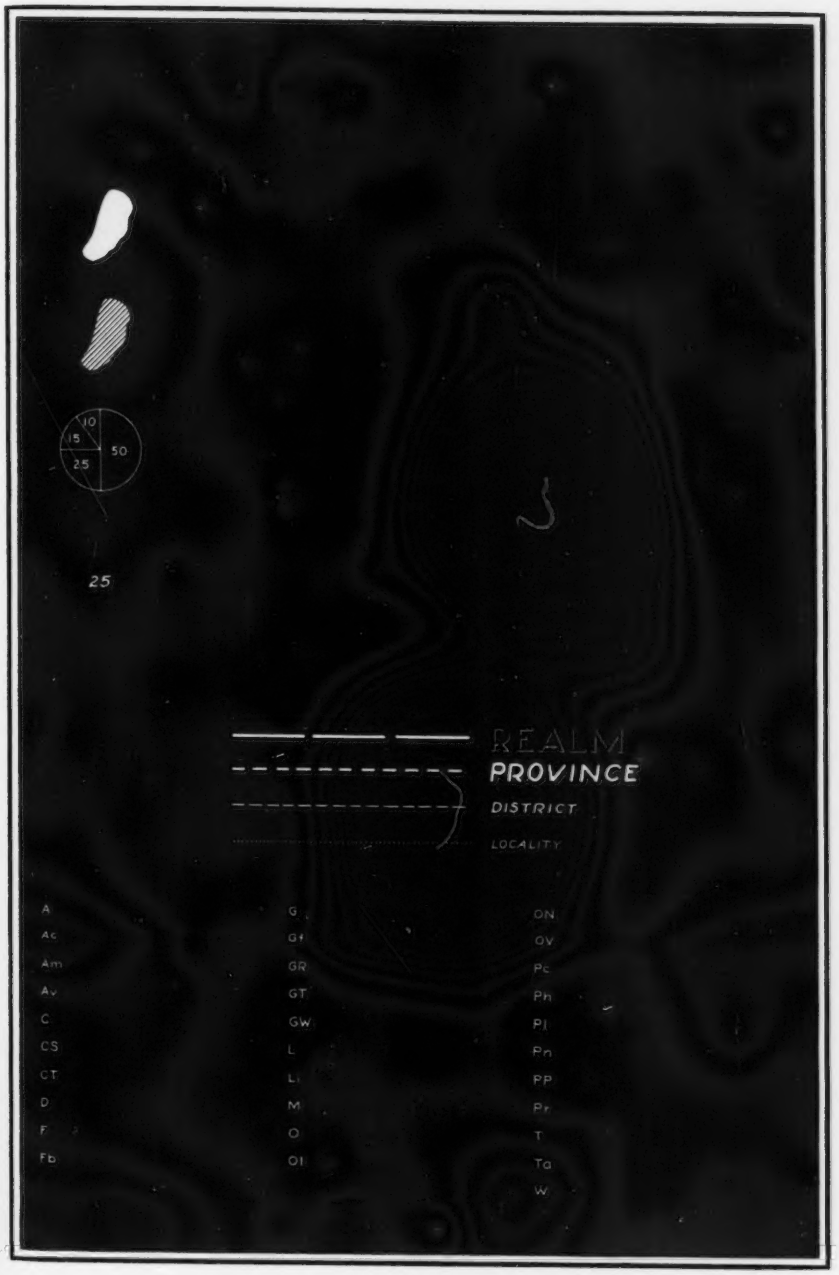
10
15
50
25
25
REALM
PROVINCE
DISTRICT
LOCALITY
A
Ac
Am
Av
C
CS
CT
D
F
Fb
G
Gf
GR
GT
GW
L
Li
M
O
Ol
ON
OV
Pc
Ph
Pl
Pn
PP
Pr
T
To
W

FIG. 5.

NORTHEASTERN ORCHARD
DOOR PENINSULA 12
NORTHWESTERN MICHIGAN
GREAT
CHEBOYGAN
CHARLEVOIX
GRAND TRAVERSE 19
NORTHWEST SHORE 9
KICKAPOO VALLEY 1
OCEANA-MASON 22
MICHIGAN
LAKE ERIE SHORE
SCATTERED 5
ROMEO 4
EASTERN OHIO SHORE 13
CENTRAL WESTERN 24
CENTRAL OHIO SHORE 7
UPPER MISS. VALLEY
WESTERN
SOUTHEASTERN
SOUTH OAKLAND 13
WESTERN OHIO SHORE 9
AKRON 5
UPPER OHIO VALLEY 24
SOUTHWESTERN MICHIGAN 95
ALLEGHENY HILLS
MIDDLE OHIO VALLEY 8
CALHOUN 12
DRIFT PLAINS 10
SOUTH-WESTERN OHIO 4
VINCENNES 2
SOUTHERN ILLINOIS-INDIANA
MIDDLE APPALACHIAN RIDGES
NORTHERN 44
MIDDLE 9
SHENANDOAH
SOUTHERN 5
OZARK HILLS 13
MISSISSIPPI VALLEY
SOUTHERN N. CAROLINA 5

FIG. 6.

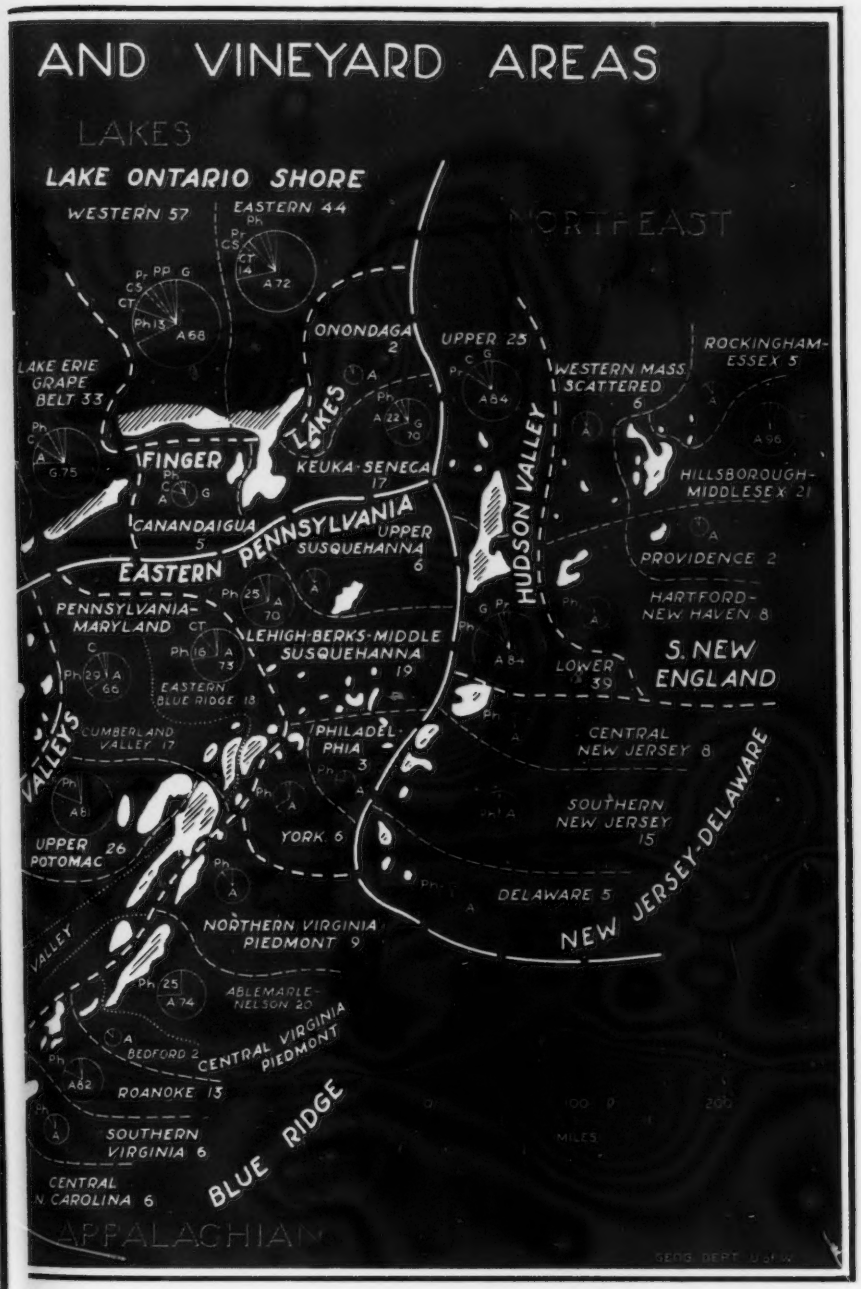

FIG. 6 (*continued*)

SOUTHEASTERN ORCHARD
Ph
G
A
NORTHWEST ARKANSAS 14
OZARK-OUACHITA
CLARKSVILLE 8
NASHVILLE 13
SOUTHEASTERN
PERRY 13
Pc
T 97
MOBILE BAY 18
Pc 90
LOUISIANA-MISSISSIPPI
PEARL RIVER 78
SOUTHEASTERN
Pc
T 95
Pc
T 74
STONE HARRISON
GULF
COAST
SOUTHEASTERN
MISSISSIPPI DELTA 3
43
57
LOWER RIO GRANDE 152

FIG. 7

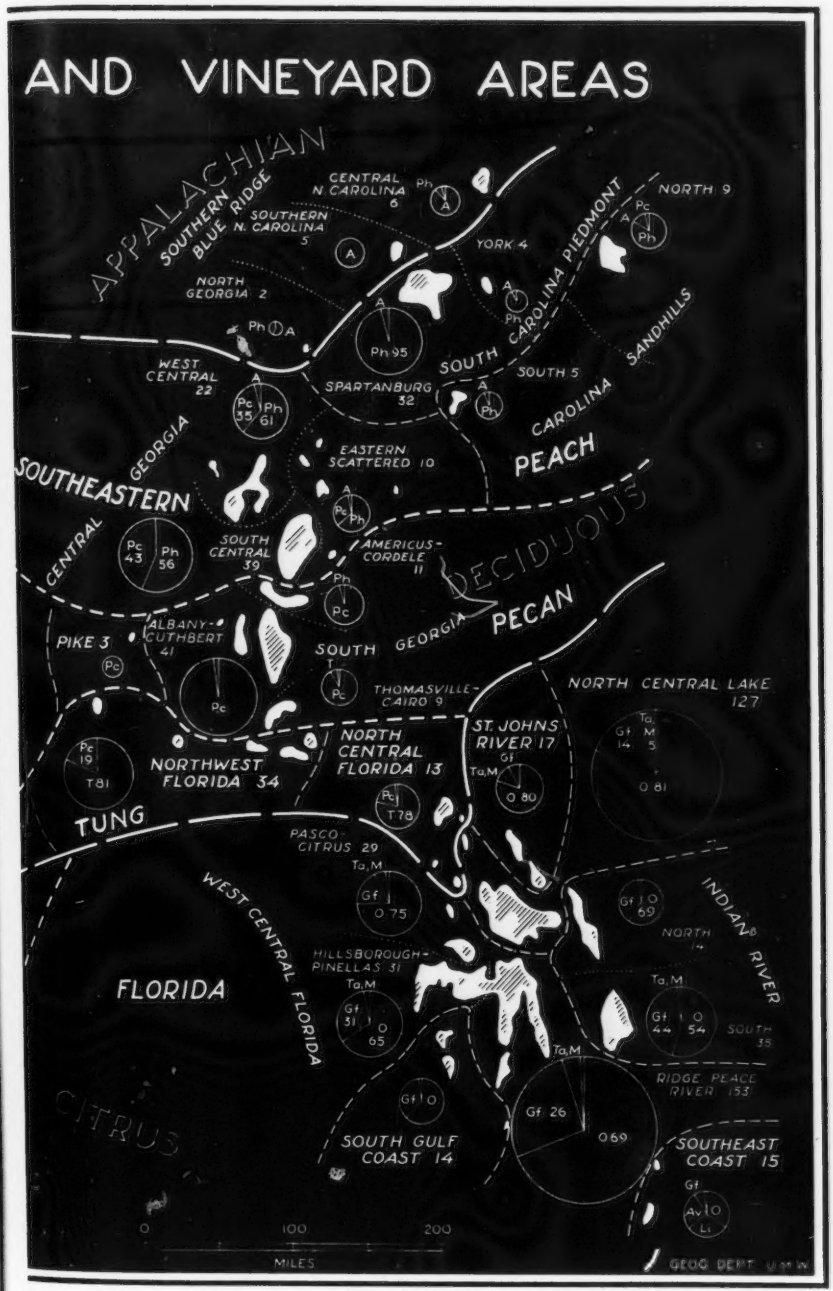

FIG. 7 (continued).

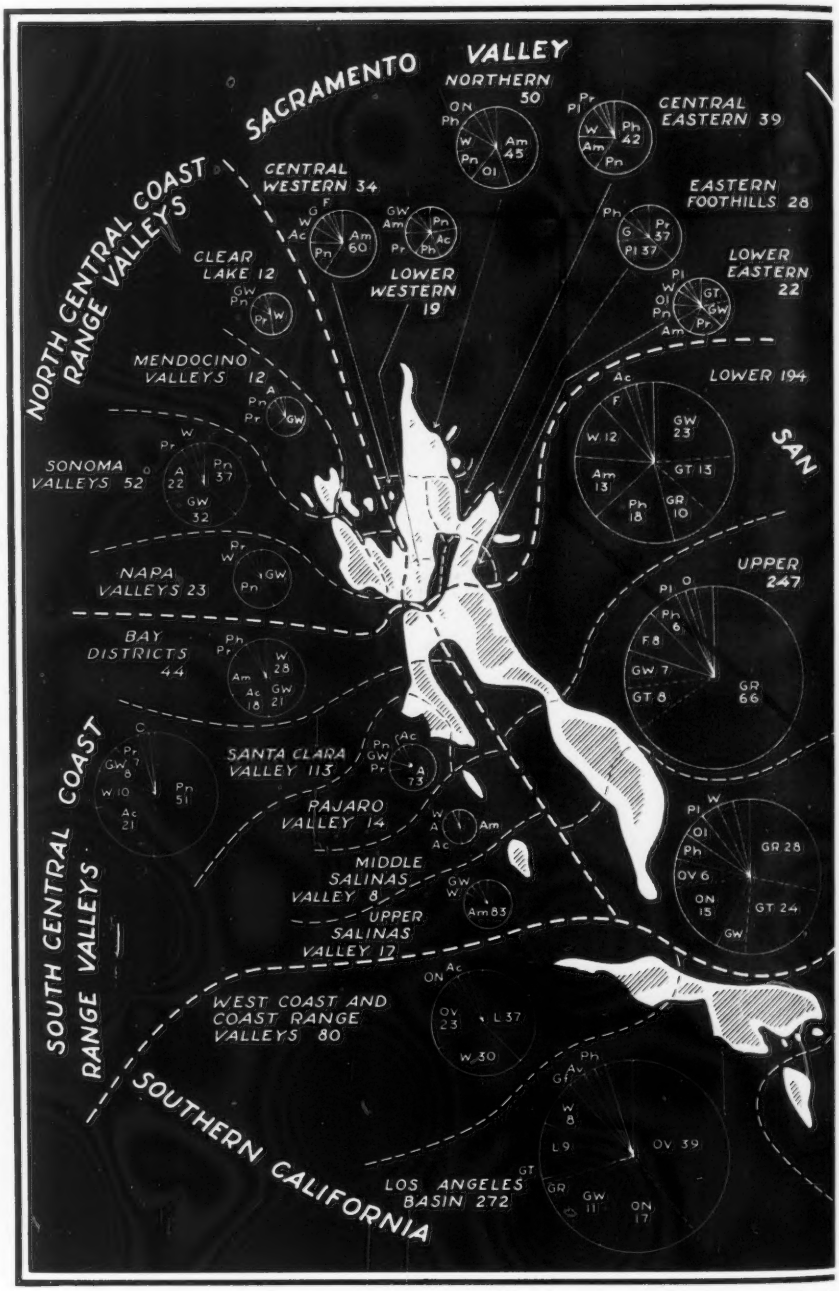
SACRAMENTO VALLEY
NORTHERN 50
CENTRAL EASTERN 39
CENTRAL WESTERN 34
EASTERN FOOTHILLS 28
CLEAR LAKE 12
LOWER WESTERN 19
LOWER EASTERN 22
NORTH CENTRAL COAST RANGE VALLEYS
MENDOCINO VALLEYS 12
LOWER 194
SONOMA VALLEYS 52
SAN
NAPA VALLEYS 23
UPPER 247
BAY DISTRICTS 44
SANTA CLARA VALLEY 113
PAJARO VALLEY 14
MIDDLE SALINAS VALLEY 8
UPPER SALINAS VALLEY 17
SOUTH CENTRAL COAST RANGE VALLEYS
WEST COAST AND COAST RANGE VALLEYS 80
SOUTHERN CALIFORNIA
LOS ANGELES BASIN 272

FIG. 8.

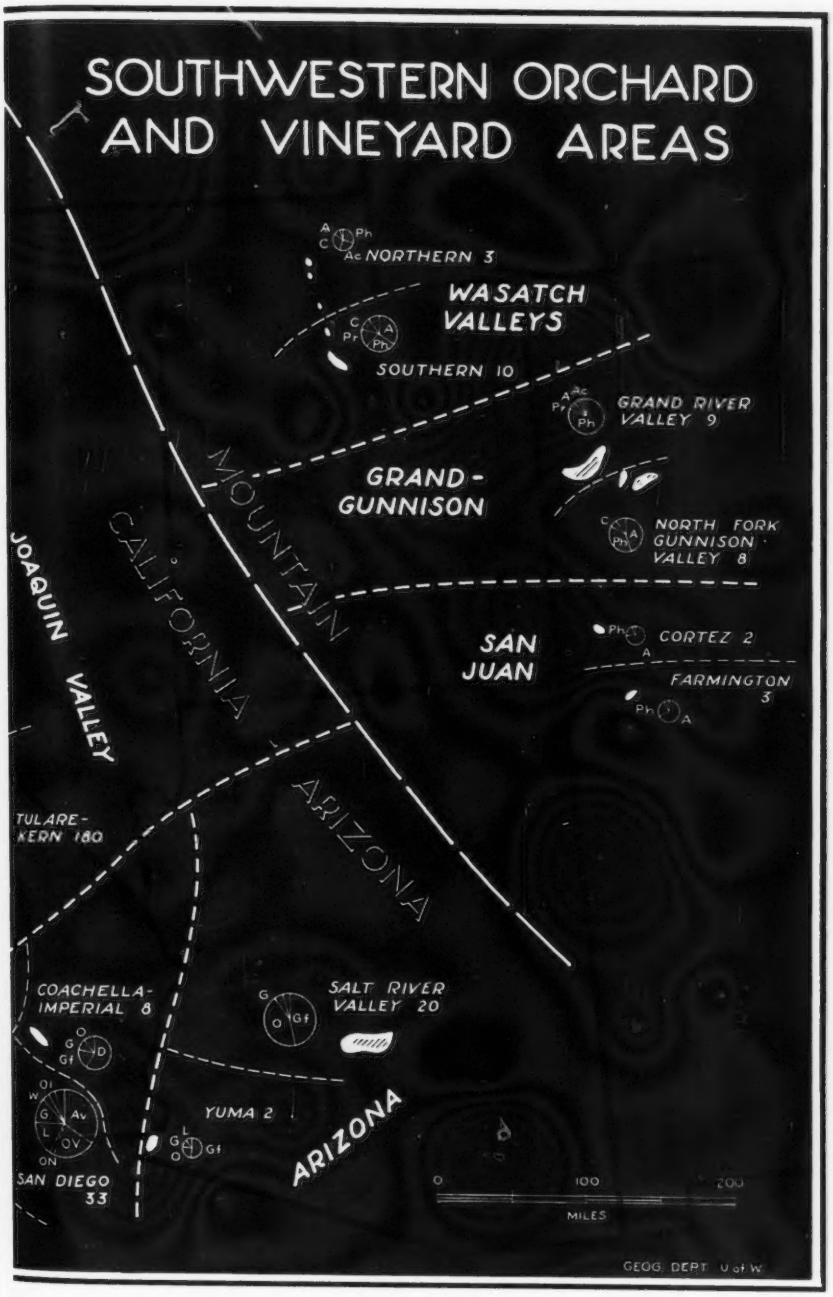

FIG. 8 (*continued*).

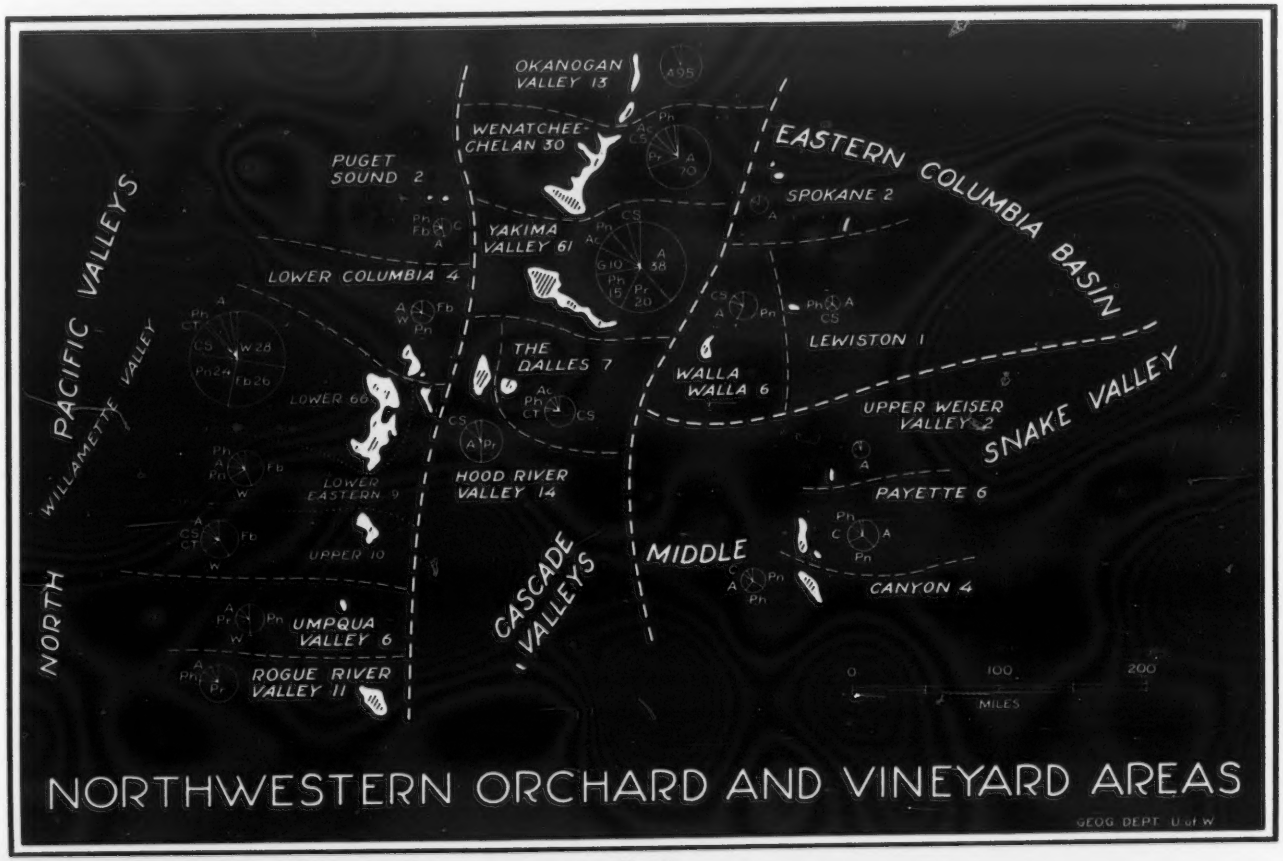
OKANOGAN VALLEY 13
WENATCHEE-CHELAN 30
PUGET SOUND 2
EASTERN COLUMBIA BASIN
SPOKANE 2
YAKIMA VALLEY 61
LOWER COLUMBIA 4
NORTH PACIFIC VALLEYS
WILLAMETTE VALLEY
LEWISTON 1
THE DALLES 7
WALLA WALLA 6
LOWER 60
UPPER WEISER VALLEY 2
SNAKE VALLEY
HOOD RIVER VALLEY 14
LOWER EASTERN 9
PAYETTE 6
UPPER 10
CASCADE VALLEYS
MIDDLE
CANYON 4
UMPQUA VALLEY 6
ROGUE RIVER VALLEY 11
0 100 200
MILES
NORTHWESTERN ORCHARD AND VINEYARD AREAS
GEOG. DEPT. U. of W.

FIG. 9.

plies. A small farm orchard, or even a few large modern orchard establishments, may operate successfully on the basis of a limited local market. But such an individual operator is handicapped in meeting the keen competition offered in large, distant markets by established orchard and vineyard regions which have developed the organization and services not only for efficient production, but also for low cost grading, packing, processing, advertising, shipping, and selling.

Within a competitive framework, the growers, processors, and researchers of a specialized orchard and vineyard region pool their information and coordinate their attack upon problems of production, processing, and marketing. Research is carried on by public and private agencies and the findings disseminated through fruit journals, horticultural societies, specially trained agricultural agents, salesmen, demonstrations, and discussions. The successful innovations of the few resourceful growers become the standard practice of the many. The supreme objective is excellence in management of a specialized enterprise. The climate, land type, and market relationships can be modified little, if at all. It is their evaluation by people, and the management and organization which are applied to them, that are susceptible of improvement. If the evaluation is sound and the management efficient, further specialization and localization develop.

In humid eastern Anglo-America specialized orchard and vineyard regions developed in answer to an increasing market demand for quality fruit, and within a framework of permissive economic, technological, and natural environmental conditions. Their distributional arrangement is the empirical result of group evaluation of the permissive conditions, especially of the relationships to market, the climatic effect of water bodies and highlands, and the comparative suitability of land types. The selection of specialized fruit growing, as the use to which the relatively rough lands and sandy soils of the current orchard regions should be put, often followed a period of sparingly successful attempts on these lands to emulate the more general crop farming practiced on smoother surfaces and heavier soils. In almost every case, excepting the southeastern citrus areas, the present orchard or vineyard specialization is an evolutionary development out of the ubiquitous kitchen and farm orchards of earlier times.

THE DEVELOPMENT OF ORCHARD SPECIALIZATION IN THE WEST

Although the earliest domestic fruit trees and vines of the West were those of the Spanish missions, and of the Russian settlement at Fort Ross, here too it was mainly the kitchen and farm orchards of westward moving Americans that provided the base for the modern industry. Settlers moving into the Willamette Valley before 1850 and into central California in the following decade brought precious seeds and later ordered nursery stock from settled eastern areas.

The same factors which had operated in the evolution of eastern orchard and vineyard regions were present, also, in the West, but in greatly different character. To the small, local, western markets, there were suddenly added, through the development of transcontinental railroads and refrigeration in the eighteen seventies and eighties, eastern markets that had already acquired large size and quality consciousness. Farmers who had haltingly and painfully come to appreciate the small but significant climatic advantages derived from water bodies or highland

barriers in the East discovered a much more permissive climate in the Far West. Whether they realized it or not, the air conditioning effect of Pacific waters, the double barrier provided by the Rockies and Cascades–Sierra Nevada against the backward invasion of continental air in winter, and the variety of altitude and exposure combinations available among the mountains and valleys provide the Far West with an unusual endowment for the production of a variety of middle-latitude and semi-tropical fruits and nuts. It remained for farmers only to evaluate the great variety of land types for specific tree or vine crops, to provide water for their growth, and to devise a system which could dispose of the products profitably on the distant markets, all considerable and continuing tasks.

In more humid areas such as the Willamette Valley, the coast range valleys of northern California, and the lower western foothills of the northern Sierra Nevada, farmers used the ways of the East in selecting lands for orchard specialization. Slopes too steep and soils too sandy or gravelly for optimum production of field crops were found adequate or preferable for orchards.

In the valleys and lowlands of central and southern California and the eastern Cascades, however, only the costly provision of irrigation water could permit replacement of extensive grazing or dry farming by more intensive production of field, orchard, and vineyard crops. Water could be provided most easily to the great alluvial fans or plains at the foot of mountains. The natural fertility of the coarse alluvial soils not only made them adaptable for field crops, but their excellent drainage made them also ideal for trees or vines. Although natural air drainage was slower than on low mountain slopes or morainic hills in the East, it was adequate on valley sides and terraces and on the middle and upper parts of alluvial fans, especially in a land less often plagued by low temperatures. Here was a situation rarely known in the older East, except for the more recently developed Florida and Lower Rio Grande areas: orchards and vineyards competing with field crops for the initial, non-extensive use of the best and most valuable lands—and often successfully.

Western Orchard and Vineyard Regions

As in the eastern United States, orchard and vineyard specialization on a commercial scale developed first on unirrigated, moderately rough lands with sandy, gravelly soils. Many important developments in the breeding and dissemination of useful varieties occurred in these areas, for example the work of the Lewellings in the Willamette Valley, Felix Gillet at Nevada City in the northern Sierra foothills, or A. T. Hatch in the Suisun Valley.[36] These areas have retained importance as largely unirrigated orchard or vineyard regions, as have the Dalles area of Oregon (sweet cherries), and, in California, the Sebastopol locality of Sonoma County (apples), the Pajaro Valley and adjacent hills (apples), the upper Salinas Valley (almonds), the Napa, Sonoma, and Santa Rosa Valleys (wine grapes and prunes), and the Suisun and Vaca Valleys of the Lower Western Sacramento district (prunes, apricots, peaches, pears, and grapes). Some formerly unirrigated orchard areas, such as the Hood River Valley, are now largely irrigated. Others where most orchards remain unirrigated, such as the upper Salinas Valley almond

[36] *Yearbook of Agriculture, 1937, op. cit.*

district, are losing pre-eminence to smoother, better watered areas.

In most western orchard and vineyard areas, however, the relatively high and regular yields are dependent upon the controlled application of water. Without exception these irrigated districts lie on the alluvial soils of mountain valleys or piedmonts. They may arbitrarily be separated, on the basis of magnitude, into two groups: (1) those whose areas are restricted by the smallness of the valley or of the irrigable piedmont possessed of suitable soil and climatic conditions; and (2) large areas whose coalescing alluvial fans comprise extensive piedmont plains.

Small Mountain Valleys and Piedmonts

Many of the small, mountain-enclosed valleys are among the most highly specialized orchard regions in the country. These include the Okanogan Valley at the eastern base of the Cascades and a whole series of valleys furrowed in their eastern slope: the Methow, Chelan, Entiat, and Wenatchee Valleys of the Wenatchee-Chelan district; and the Yakima and Hood River Valleys to the southward. The Yakima Valley is much the largest, but most of its great production of fruit comes from the restricted upper section near Yakima City between Umtanum and Ahtanum Ridges, including the Naches Valley and Tieton Plateau, and from smaller districts along the northeastern margin of the lower valley. On the western side of the Cascades, the Bear Creek arm of the Rogue River Valley near Medford is a major producer of pears. Among the South Central Coast Range Valleys near San Francisco Bay, the large Santa Clara Valley is largely devoted to prune and associated apricot, pear, and walnut orchards; pear and walnut plantings cover much of the smaller Ygnacio Valley; vineyards are important in Livermore Valley. In southern California the adequately drained alluvial soils of the relatively small Ojai, Santa Clara, and Simi Valleys of the West Coast and Coast Range Valleys District, and the San Fernando, Santa Ana (Riverside), and San Jacinto (Hemet) Valleys around the margins of the Los Angeles Basin, are utilized primarily for oranges, with lemons, walnuts, and apricots also important. In the Rocky Mountains, the Grand (Colorado) River Valley specializes in peach production, with apples more important in the higher North Fork Gunnison Valley and on the south-facing slopes of adjacent Grand Mesa. Although fruit-growing is secondary among several important agricultural enterprises in the valleys at the western base of the Wasatch, orchards are more or less continuous on the well-drained sites along the upper margin of the irrigated piedmont. Small areas are likewise devoted to orchards in the Snake-Boise (Canyon district) and Payette Valleys of Idaho. Fresh prunes are a major crop of the Walla Walla Valley at the northern base of the Blue Mountains.

In some of the relatively small orchard regions, the area devoted to orchards is limited not by surrounding mountains but by the scarcity of suitable irrigable soils or by competitive land uses. In the Oxnard area of coastal southern California, and more especially near Santa Barbara, the alluvial piedmont soils suitable for orchard use are narrowly confined between the mountains and the sea. In the San Fernando Valley, as well as on the opposite side of Los Angeles, expanding urban uses are rapidly pre-empting orchard lands. This is also true northeast of Sacramento and in areas near San Francisco Bay such as the Ygnacio and northern Santa Clara Valleys. In

the nonurbanized Imperial Valley, orchards have made but little headway in competing with field crops for use of the low, flat land. In the Coachella Valley extension of the same structural trough, only small areas have been reclaimed for orchards, mainly for date production. Irrigable land is likewise more plentiful than the necessary water in the Salt River Valley of Arizona. Here the relatively small citrus districts are limited to the higher margins of the irrigated area near the bases of the Arizona Highlands, and the outlying Salt River, Phoenix, and White Tank mountain ranges.

Large Alluvial Valleys and Piedmonts

The largest, more-or-less continuous areas of orchard and vineyard in the world are in the Central Valley and Los Angeles Lowland of California. As in the eastern United States, the trees and vines occupy sandy or gravelly soils somewhat elevated relative to adjacent surfaces so as to provide adequate drainage for soil water and surface air. But, unlike the East, many of these smooth, gently-sloping sites are, when watered, among the most desirable also for field crops. Their use for trees and vines results from successful competition rather than simply from default.

In the Central Valley, some orchard areas are on slightly elevated terraces of older alluvium, a situation more typical in smaller mountain valleys such as those of the Cascades. The Corning almond district in the northern Sacramento Valley and the Citrus Heights vineyard and orchard district northeast of Sacramento are examples. Other orchard districts are confined to the crests of natural levees that stand slightly above the heavier soils of the floodplains. Such areas include the prune and almond district along the upper middle Sacramento River between Glenn and Colusa, as well as the old River Pear District along the winding lower Sacramento from Clarksburg to Isleton.

More typical are the orchard districts situated on alluvial soils of mountain piedmonts. Some are relatively small, the size of the piedmont tracts corresponding to the smallness of the mountain streams by which they were built. The narrow zone of prune, peach, and almond orchards from Red Bluff to Los Molinos in the Northern Sacramento Valley is an example. So too is the Brentwood almond and apricot district lying at the base of the Coast Ranges just south of the Delta. The thin scattering of vineyards and orchards which extends for 60 miles southeastward from the Brentwood district is indicative not so much of the narrowness of the piedmont plain along this western side of the San Joaquin Valley as of the longtime scarcity of water. Orchards and vineyards occupy the narrow piedmont along the opposite side of the Coast Ranges from Hayward to the mouth of the Santa Clara Valley. In the West Coast district of southern California, the zone of lemon groves lying between the base of the Santa Ynez Mountains and the sea, or those at the northwestern margin of the Oxnard Lowland, occupy similar restricted piedmont locations.

The vast acreages of orchard and vineyard for which California is famous occupy areas different from the foregoing piedmont situations only in scale. They extend almost continuously around the landward margins of the Los Angeles Lowland and along the western base of the Sierra Nevada from north of Bakersfield to east of the Delta. They are only less extensive and continuous along the eastern and

lower western margins of the Sacramento Valley.

Along such mountain piedmonts the distribution of orchards and vineyards coincides markedly with the outlines of the individual and coalescing alluvial fans. Vineyards extend farthest down slope, although few reach, for example, to within five miles of the axial river in the bottom of the San Joaquin Valley. The deeper rooted fruit and nut trees occupy the higher, better-drained parts of the fans; citrus groves, where present, occupy the highest and most frost-free portions. Soils are sandy and gravelly, with coarseness increasing upstream toward the narrowing apexes of the fans. Most are mapped as belonging to the Yolo or Hanford series of young alluvium or to the sandy phase of the slightly older and more maturely developed Fresno series.[37]

The greatest series of piedmont alluvial fan orchard and vineyard districts begins with that on the alluvial deposit of the Mokelumne River in the Lower San Joaquin Valley east of the San Joaquin–Sacramento Delta. The vineyard district of this medium-sized fan comprises a sector enclosed by 15-mile radii from the apex above Lockeford and a 12-mile arc at the base. The surface slopes gently and decreasingly from an elevation of 100 feet above sea level at Lockeford, where the one-half to one-mile wide river floodplain is forty feet lower, to only 15 feet above sea level at the lower edge where vineyards give way abruptly to field crops and where the slightly entrenched stream bed must be confined by artificial levees. The continuous expanse of vineyards is interrupted only by the sandy stream bed, the centrally located trading city of Lodi, and the occasional blocks of peach, almond, prune, or sweet cherry orchard which become more numerous near the better-drained apex.

To the southward the alluvial fans of the Calaveras River and Littlejohns Creek above Stockton are smaller and are narrowly separated from each other and from the Mokelumne and Stanislaus fans on either side by poorly-drained, slough-traversed lowlands. Much of the sandy Yolo soils on the fan surfaces are planted with peaches. Southeast of Stockton the large coalescing fans of the Stanislaus, Tuolumne, and Merced Rivers are utilized chiefly for vineyards and peach orchards, with many acres of almonds and apricots. Between Merced and Madera the orchard and vineyard region narrows somewhat where smaller streams such as the Bear, Owens, Mariposa, Chowchilla, and Fresno have built a narrower plain of coarse alluvium. Beyond Madera, however, in the Upper San Joaquin and Tulare-Kern districts, the great coalescing fans of the San Joaquin, Kings, and Kaweah Rivers comprise one of the world's greatest vineyard areas. On the upper part of the Kaweah fan and the narrowing piedmont southward past the Tule River, oranges are of primary importance. Thus, from the Mokelumne to the Tule River, vineyards and orchards extend almost continuously over the piedmont alluvial plain for well over two hundred miles.

As compared with the San Joaquin Valley, the bigger and more regularly flowing streams which enter the Sacramento Valley have built larger areas of poorly drained floodplain and smaller ones of well-drained, coarse alluvium. Orchard and vineyard regions, consequently, are smaller and less continuous. The greatest is on the compound alluvial plain of the Feather,

[37] C. F. Marbut: "Soils of the United States," Part III of *Atlas of American Agriculture*, U. S. Department of Agriculture, Bureau of Chemistry and Soils, Washington, 1935.

Yuba, and Bear Rivers centered in the Central Eastern Sacramento Valley. This orchard area extending for more than 40 miles from Oroville past Marysville to Nicolaus produces half of California's canning peaches plus large quantities of prunes and almonds. Farther north the compound fan of Big Chico and Big Butte Creeks comprises the great Chico almond district. The only relatively large alluvial fan devoted to orchards or vineyards along the eastern base of the Coast Ranges is that of Putah Creek which enters the Central Valley near Winters west of Sacramento. It is utilized for apricot, almond, and peach orchards.

In southern California there are no streams to compare in size with those of the Central Valley. The compound, piedmont alluvial fans of a number of small and intermittent streams, however, comprise one of the major orange-producing districts of the world. The largest single fan is that of the Santa Ana River southeast of Los Angeles. From the apex where the stream emerges from its gorge through the Santa Ana Mountains, the radiating edges of the fan extend westward and southward for 12 miles so that the citrus groves along the 15-mile-long basal arc reach to within eight miles of the Pacific. The citrus orchards of the Santa Ana fan merge with those along the southwestern piedmont of the Chino and Puente Hills to the northward. These orchards, in turn, adjoin those of the lower San Gabriel fan west of Whittier, making a 30-mile-long zone of citrus groves lying along the southwestern piedmont of the Santa Ana Mountains and their northwestward-extending foothills.

An even larger area of near-continuous citrus orchards and vineyards extends the 50 miles from Los Angeles to San Bernardino along the piedmont alluvial plain at the southern base of the San Gabriel Mountains. Built by the wash from a dozen mountain canyons, the plain of sandy alluvium is partially separated by the Puente, Chino, and San Jose Hills near Pomona into a western San Gabriel and an eastern San Bernardino Valley. As on the Santa Ana fan and in the San Fernando Valley, the valuable and productive orchard area is shrinking before the relentless expansion of cities.

TRENDS

The present, scattered concentrations of commercial orchards and vineyards in the eastern United States developed from a base of more uniformly widespread kitchen and farm orchards whose pleasing aspect is rapidly being erased from the rural landscape. The concentrations are the result of agricultural specialization, which has developed apace with increasing commercialization, mechanization, organization and technology. The fact that growers of fruits and nuts, like the producers of every other agricultural commodity in modern America, should specialize their productive efforts in order to win or maintain their individual shares of an increasingly large and discriminating competitive market, was inevitable. The only question was who should develop what specialties in what areas, by what processes, and with what success and permanence. The key to the developing pattern lies in the capacity of farm operators, in a modified competitive system, to evaluate the productive potentialities of their lands and market situations, and to select and develop, accordingly, specialized uses for that land.

Through trial, error, and study, men have learned much about both the hazards and advantages for agriculture of local climates and land types. As

they chose or were forced to specialize, they learned that the sandy, gravelly soils on relatively steep slopes, which could not compete with smoother, more fertile land in the growing of field crops, were actually preferable for deep-rooted trees and vines. To some the opportunity dawned after years of niggardly successful tillage of marginal land. Others, with a specialized venture in mind, acquired such land purposely and cheaply. Such chosen lands usually combined relative advantages of climate and land type with convenience to market. Examples are the orchards on sandy, hilly moraines along the leeward shore of Lake Michigan opposite the Chicago and Milwaukee markets, the hilly orchard districts nestled below the Catskills in the Hudson Valley, and those on the sandy coastal plains adjacent to metropolitan New York and Philadelphia.

Further stimulus to local specialization in the East came with increasing competition from the developing West. Some of the early beginnings in the West followed eastern precedents. Kitchen orchards on moderately rough lands in the Willamette Valley, among the western foothills of the northern Sierra Nevada, and in valleys among the Coast Ranges north of San Francisco Bay were gradually expanded into commercial enterprises in order to supply nearby markets. But the great orchard and vineyard regions of the West, such as those in the Los Angeles Lowlands, and the San Joaquin, Sacramento, Santa Clara, Yakima, and Wenatchee Valleys, were initiated as specialized, commercial enterprises on first class lands to supply large markets in the East—the same markets on which the specialized eastern districts were basing their development.

Lack of water is the great impediment to development of agriculture in the West. But, provided the cost is spread sufficiently, the creation of irrigation systems changes adversity to advantage for the chosen lands. In order to spread water over the land, fruit growers avoided steep slopes, thus losing some advantage for natural air drainage. But in a land of generally mild temperatures this has not proved serious, especially since, at the same time, it assures less soil erosion and better conditions for mechanized and efficient production and harvesting operations.

A second handicap to the development of commercial agriculture in the West has been distance from the country's major markets. But this adversity, also, the western fruit industry has, in a way, turned to its advantage. In order to compete in distant eastern markets, which were virtually next door to the orchards of their competitors, western growers have from the first striven to produce a uniform, high quality, handsome fruit, to package it attractively, to advertise it widely, and to place it on the eastern market in first class condition, all at minimum cost. Refrigerated rail shipment was developed in the 1880's to distribute the quality products from the expanding acreages of irrigated orchards and vineyards. Western orchardists have been diligent in plant breeding and disease control, and have led the industry in grading, packaging, and selling. The whole has been achieved through intensive specialization.

Competition from the West has spurred specialization in the East. Kitchen orchards have nearly disappeared. The farm wife buys a pliofilm bag of Washington Winesaps in preference to paring worms from the uncared-for product of the home orchard. Farm orchards have been expanded so as to merit investment in and efficient use of spraying, pruning, tillage, and harvesting equipment, or, more com-

monly, they have been abandoned. The processes of abandonment in most areas and intensification in a few have gone on simultaneously. Some districts, such as those in the Ohio and lower Missouri Valleys, have experienced the full sequence: initial, widespread kitchen orchards, the development of localized commercial orchard regions by 1900, and almost complete abandonment since. Other currently specialized districts, such as those in southern Illinois, northwestern Arkansas, or the Allegheny hills, are trying, in the face of competition from more specialized areas, to ward off the final abandonment phase.

Only those eastern regions are prosperous which enjoy advantages of land type, climate, and convenience to market, and whose growers have specialized their farm operations so as to compete with the West in producing and selling fruit of uniformly high quality. The economy of such areas, and especially of the individual farms within them, is becoming more specialized in fruit production. Erosion and depletion of sandy soils on steep slopes are being countered by careful management and, especially, by selection of the gentler slopes and better soils within the hilly regions as orchard sites. Operations are becoming mechanized, scientific, and larger in scale. Grading and packing rules are more rigidly enforced; the product more selective and widely advertised. Many favorite old varieties are being abandoned; new ones are developed to fit particular market preferences at opportune times. Individual areas specialize in particular varieties; for example the Shenandoah Valley in York Imperial and Stayman apples, western Michigan in Jonathan and McIntosh.

The area devoted to orchards and vineyards in the United States reached a peak in 1927, after the development of most specialized fruit-growing regions, especially in the West, but before the final abandonment of the widespread, deteriorating farm orchards, especially in the East. The more than 5 million acres of orchard and vineyard estimated for 1927 declined almost 13 per cent to a low of 4.4 million acres in 1941, since which time there has been a small increase.[38] The peak acreage in the late nineteen twenties correctly represents the situation for peaches, pears, plums and prunes, apricots, grapes, figs, and olives, all of which reached their maximum area between 1924 and 1932, inclusive. Obscured is the fact, however, that apple acreage, which represented approximately 44 per cent of the 1927 total, was midway in a long, steady decline, while the acreage of citrus fruits, nuts and cherries, representing about an eighth of the 1927 total, was increasing so rapidly that by 1946 their share of the total orchard and vineyard area had increased to 27 per cent.

Marked decline in apple acreage after 1920 is a logical consequence of the increasing specialization of fruit and nut production and, more specifically, of the concomitant abandonment of farm orchards. Individually small farm orchards, largely comprised of hardy old varieties of apple trees, collectively accounted for a large proportion of the nation's apple acreage. Their yield, however, was low per tree and per acre. American apple acreage was probably near its maximum in 1904 when the all-time production record of nearly 234 million bushels was recorded.[39] By 1920 when, despite declining acreage,

[38] Comparative acreage data are from *Fruits and Nuts, Bearing Acreage, 1919–1946*, Crop Reporting Board, Bureau of Agricultural Economics, U. S. Department of Agriculture, Washington, D. C., 1949, and from succeeding reports of the same agency.

favorable conditions resulted in the tenth highest total production in history, the yield per acre of all orchard was approximately 80 bushels. In 1950 the yield from apple trees within the specialized orchard and vineyard regions mapped herewith was, by contrast, more than 150 bushels per acre. During the period 1919–1928, the mean average annual yield per acre of all bearing apple orchard was 68 bushels; during 1937–1944 the yield from commercial areas was nearly double that figure. Despite the nostalgia of many consumers for old varieties, it is probably true also that the early crops, derived in considerable part from farm orchards, contained much fruit unmarketable under modern standards of quality. Nevertheless, total production and consumption of apples, if not commercial production, has declined in the United States during this century.

The increase in yields per plant and per acre that has resulted from the better methods accompanying specialization has more than compensated for the slight decline, since the nineteen-twenties, in the acreages of peaches, pears, plums and prunes, grapes, apricots, figs, and olives. Rising yields have not, however, counterbalanced the marked decline in apple acreage. The decline in total production of apples, and the rather moderate increases in production of the other fruits mentioned, indicate a trend of great significance to the orchard and vineyard industry—change in the American diet.

It may not be incorrect to say that some parts of the orchard and vineyard industry are, through new techniques of production, processing, distribution, and promotion, stimulating dietary changes, whereas less aggressive members of the industry are resisting these changes but having to adjust their operations to them. In 1910 the average American consumed more than 60 pounds of apples and less than 18 pounds of citrus fruits. By 1952 his consumption of apples had been cut to less than half while his demand for citrus had increased fivefold.[40] Per capita consumption of apricots, figs, cherries, pears, and plums and prunes has increased slightly. That of peaches and grapes has been barely maintained.

Expansion in the acreage, production, and consumption of citrus fruits has been the most significant recent trend in the geography of orchard and vineyard crops. Bearing acreage has tripled during the last 25 years. However, while California's share of the nation's bearing citrus acreage decreased from approximately two-thirds in 1920 to a little over one-third in 1950, Florida's share increased from less than 30 to more than 52 per cent during those years. Texas and Arizona, with negligible acreages in 1920, possessed about ten and two per cent, respectively, of the national acreage in 1950. Acreage in all four states increased until 1940, since which there has been a small but steady decrease in the water-deficient Salt River Valley. In the Lower Rio Grande Valley acreage increased rapidly from the beginnings of the industry about 1920 until curtailed by the disastrous freezes of January 1949 and January 1951. California's citrus acreage increased steadily, often spectacularly, from its beginnings about 1880

[39] Comparative production data are from *Fruits (noncitrus): Production, Farm Disposition, Value, and Utilization of Sales, 1889–1944*, Crop Reporting Board, Bureau of Agricultural Economics, U. S. Department of Agriculture, Washington, D. C., 1948, and from other reports by the same agency for citrus fruits and for later years.

[40] *Consumption of Food in the United States, 1909–52*, Agriculture Handbook No. 62, Bureau of Agricultural Economics, U. S. Department of Agriculture, Washington, D. C., 1953.

until the end of World War II. Since that time more than 50,000 acres of citrus groves have been uprooted in southern California to make way for the ever-expanding cities. Meanwhile Florida's citrus boom continues unabated. In the 1920's, canning of citrus segments was introduced to augment the fresh fruit market. In the 1930's the canning of orange and grapefruit juices encouraged continued planting during a period of general economic depression. In the early 1940's came the development of canned citrus concentrate. Finally, a decade ago when expanding production threatened to glut the market, frozen concentrate was developed and effectively promoted. In 1952, six years after its appearance on the market, frozen citrus juice was consumed in the United States at the annual rate of more than 11 pounds per capita (single-strength equivalent).[41] New plantings continue to be added to the long-lived old ones as Florida's citrus groves play an increasingly important role in the economy of the state and in the orchard and vineyard industry of the nation.

Only seven states significantly increased their acreages of tree fruits and nuts, excluding citrus, during the period 1920–1946. Increases of 8 to 18 per cent in Louisiana, Mississippi, and Florida result from recent establishment of the Gulf Coast tung nut industry. The near-threefold increase in South Carolina reflects the spectacular development of the Spartanburg peach district after 1920. Increases of about 7, 13, and 47 per cent in Oregon, Michigan, and California, respectively, represent expansion of already established orchard and vineyard regions. The marked decline of apples in Oregon was balanced by increase in plantings of walnuts, filberts, cherries, and pears. Moderate decrease of apple acreage in Michigan was more than offset by increase in cherries and peaches. In California, major absolute gains were in plantings of grapes, almonds, walnuts, prunes, and figs.

The purpose of this study has been to delineate the current pattern of American orchard and vineyard regions and to postulate some of the processes and trends significant to its development and change. The stage is set, as it were, for further study. In order to measure and interpret the trends, they need to be graphed and analyzed in detail. In order to contribute toward an understanding of how man evaluates the land resource and establishes a kind and system of land use, comparative field studies need to be made of specific orchard and vineyard regions. By comprehension of the whole, it is hoped that the parts may be more effectively analyzed; through analysis of the parts, the whole will become more adequately comprehended.

[41] *Ibid.*

ACKNOWLEDGMENTS

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LIVESTOCK UNITS AND COMBINATION REGIONS IN THE MIDDLE WEST*

John C. Weaver, Leverett P. Hoag, and Barbara L. Fenton

Dr. Weaver is now Dean of the School of Arts and Sciences, Kansas State College, Manhattan, Kansas. The paper presented here is the result of research carried on while he was Professor of Geography at the University of Minnesota. Mr. Hoag and Miss Fenton were his research assistants.

THE production of both crops and livestock in the same area and even on the same farm undoubtedly is more common than the raising of either crops or livestock alone. Admittedly each is produced alone in certain places. Grazing areas, for example, where winter feeding is not required, might not employ any crop production, and, conversely, plantations or fruit and vegetable farms in irrigated areas or near urban concentrations may have no associated livestock enterprise. By and large, however, and certainly in the Midwestern United States, typically the two are raised in association with each other. For that reason a companion study on livestock similar to those recently published on crops[1] would seem to be profitable on the basis that the two main types of products from the farm could then be viewed from the same vantage point.

It must be pointed out that it is apparent that the results from these crop and livestock studies cannot be superimposed one upon the other to derive types of farming regions. The defining of such regions must involve the consideration of many other kinds of information as well. Although realizing the significance of ultimately arriving at such a result, no pretense is made to having compiled and analyzed sufficient material to reach such an advanced stage. This viewpoint should not, however, detract from the value that can be gained from a more detailed knowledge of the distribution and association of livestock types in the Middle West.

This study, though not as detailed as those on crops and though not covering the changing pattern, is essentially comparable with those portions of the crop studies which dealt with the 1949 crop distributions and the 1949 crop-combination regions. It is felt that certain advantages will accrue as a result of keeping this study comparable to the crop studies, i.e., by using the same methods and similar ratios. The area covered is the same 1081 Midwestern counties used in the crop studies, and again counties are the basic statistical units.

Working up the data on livestock from the 1950 Census of Agriculture is a more complex procedure than for crops. There is no common unit for

*Grateful acknowledgment is made of the financial assistance given this undertaking by the Geography Branch of the Office of Naval Research and the University of Minnesota. Reproduction in whole or in part is permitted for any purpose of the United States Government.

[1] See John C. Weaver: "Changing Patterns of Cropland Use in the Middle West," *Econ. Geogr.*, Vol. 30, 1954, pp. 1–47, and "Crop Combination Regions in the Middle West," *Geogr. Rev.*, Vol. 44, 1954, pp. 175–200.

reporting the many livestock categories such as acres for crops. It is necessary to convert to some common unit or attempt to use the income derived from each of the several types. Just as value of crops produced was not considered to be a good measure of a farmer's intentions or expectations because of the many factors which influence yield and prices, so it was decided that value of production would not be a good measure for livestock. In addition to this, value of production for each of the basic livestock items is not available,[2] making some other common denominator necessary. The unit which most accurately measures the quantity of any form of livestock in relation to crop production would appear to be feed consumption. Thus it was decided to use the animal feed unit as a base.[3]

After having made the decision to use animal feed units, the road was still not clear. The size of the area and the limited resources available precluded gathering the data by sampling or some other method. The most complete information available that could be handled in the time and with the resources at hand was the 1950 Census of Agriculture. The difficulties involved in using this material are many. Because certain types of animals such as hogs or turkeys are raised and marketed in less than a year, numbers on hand April 1st are not necessarily indicative of the significance of these types. Accordingly hog units are based on number sold, turkey and duck units on number raised, and other categories of livestock on the number on hand as of approximately April 1, 1950. Whereas these comparisons recognizedly are not completely satisfactory, exhaustive investigation seems to support the belief that as approximations they are as accurate as available statistical data will permit.

Through the use of additional information obtained from personnel at the Minnesota Agricultural Experiment Station, the units of the several types of livestock have been determined as shown in Table I.

The livestock items as reported by the census do not include an enumeration of dairy and beef cattle as such. To arrive at the total number of dairy cattle it was determined that to have a dairy herd which will produce the necessary replacements, a dairy farmer must keep in addition to the milk cows a number of young stock equal to half

TABLE I

ANIMAL FEED UNIT EQUIVALENTS

Livestock type	*Number per unit*
Dairy cattle	
milk cows	1
other dairy stock	2
Beef cattle	
mature beef stock	1.25
other beef stock	2.50
Hogs	(1300 lbs. per unit)
Sheep	7
Goats	7
Chickens	50
Turkeys	61*
Ducks	61*

*Note that the number of turkeys and ducks per unit is greater than for chickens. This is because chickens for egg production are kept throughout the year. Turkeys and ducks usually are marketed in less than a year. Chickens raised for broilers would need a different conversion factor, but this is a minor enterprise in most of the Midwest.

[2] For this study we have considered dairy cattle, beef cattle, hogs, chickens, and sheep as the basic livestock types. The other items reported by the census, turkeys, ducks, and goats, were considered as specialties and were handled in the same manner as crop specialties. No other livestock types were reported for the counties except horses and mules which were purposely omitted, not only because of their minor role at present but also because they are generally kept for draft purposes and not for sale.

[3] According to the Department of Agricultural Economics associated with the Minnesota Agricultural Experiment Station, one animal feed unit is defined as a mature dairy cow or that number of other livestock which will consume the same amount of feed. One unit will consume approximately 5000 pounds of total digestible nutrients per year. Special thanks are due Professor Selmer A. Engene of the Agricultural Economics Department for his general counsel.

the number of cows. The number of milk cows was reported in the 1950 Census. Therefore the dairy cattle total was calculated by multiplying this number by 1.5.

No reference to the number of beef cattle was made in the 1950 Census of Agriculture. Having determined the number of dairy cattle by the method outlined above, the remainder of the total cattle and calves over three months old was considered to be beef cattle. The ratio of mature beef stock to young beef stock was taken to be the same as that between mature and young dairy cattle.

The number of units of hogs was determined on the basis of 1300 pounds live weight per unit. The average weight of hogs was calculated for each state from figures from the Census of Agriculture on number sold, and from the 1951 Agricultural Statistics on quantity produced (live weight).[4] In Minnesota, for example, hogs and pigs sold alive in 1949 equaled 4,666,531. Quantity produced (live weight) in 1949 equaled 1,441,325,000 pounds. Therefore, the average weight per hog was 309 pounds, and it took 4.21 hogs to equal 1300 pounds or one unit.

Definitions for the other livestock types were taken from the 1950 Census categories as follows:

Sheep: Sheep and lambs born before October 1, 1949.

Chickens: Chickens, four months old and over, on hand.

Turkeys: Turkeys raised.

Ducks: Ducks raised.

Goats: Goats and kids (on hand or kept last year).

The livestock units as defined will not give as reliable ratios as do crop and cropland acreages. It is obvious that the ratio of total dairy cattle to milk cows will not always be 1.5 : 1. In areas of high milk production and accompanying high feed requirements, replacement stock may be purchased rather than raised. If this be true and the resulting ratio is less than 1.5 : 1, then beef production in the area will be underemphasized[5] and dairy cattle will be underemphasized.[6]

In areas where surplus dairy stock is raised for sale and the ratio becomes greater than 1.5 : 1, the additional dairy stock will be classified as beef cattle. The magnitude of this error cannot be estimated, but it is surmised that the dairy-beef combination found in parts of the Great Lakes Cut-Over (Fig. 14) is not actually a dairy-beef area with dairy dominant, but in reality a dairy area raising surplus stock.

Although beef cattle may be overemphasized in such areas as those just described, they will be underemphasized where dual purpose cattle are raised if all milking cows with the associated number of young stock are classified as dairy. They may be underemphasized also in beef feeding areas if the number on hand April 1st is below the yearly average.[7] The difficulties of accurately measuring beef feeding and beef raising undoubtedly account for the paucity of data available on this important phase of farming.[8]

[4] *Agricultural Statistics 1951*, U. S. Department of Agriculture, Table 443, p. 345.

[5] Fortunately beef raising in such areas usually is not important.

[6] After checking the ratio of total cattle and calves to milk cows in all of the main dairy area of Minnesota and Wisconsin, no ratio of less than 1.42 : 1 was found and only six counties were less than 1.5 : 1. This would appear, therefore, not to be a serious problem.

[7] Beef feeders are not always fed for the same length of time; thus the number on hand at any specified date might not be representative of the year's activity.

[8] The terms "beef raising" and "beef feeding" have slightly different connotations. "Beef raising" is reserved for that type of activity where the beef cattle are raised entirely within the local area. "Beef feeding" will include those cattle imported for that purpose.

The lack of exact comparability in definitions and the inaccuracies that may arise using the accepted dairy and beef ratios can, of course, result in minor errors in this study. Cross-checking the results using livestock unit data with the available information on value of production for the various items, leads one to believe that the results are reasonably valid. No more accurate measures could be derived from available resources, and, though individual county ratios may be in slight error, the over-all patterns appear to be satisfactory.

CONCENTRATION OF LIVESTOCK PER UNIT AREA

Because the data on individual livestock types are presented here in relative terms, as a per cent of total livestock units, it is necessary to examine them in the light of Figure 1 which shows the density of units per 100 acres of total land area. This map shows the concentration of livestock on the land. While it is helpful to use relative data when comparing the different types, the density figures are needed to measure the actual strength in any area.

Within the mapped region the density varies from less than one per 100 acres in several counties in the Great Lakes Cut-Over, to 31 units per 100 acres in Cedar County in east central Iowa. In all probability the low densities would be expected in the areas where they occur. The low concentrations in the Cut-Over and the wheat growing regions of the Great Plains could be predicted. The low density per unit of total land area in the grazing regions of the Great Plains is in direct contrast to that of density per unit of cropland as measured several years ago for the same area,[9] but the small percentage of cropland in the area readily accounts for this difference. Again as expected, the hill lands to the south and east of the traditional Corn Belt as well as the cash-grain area of Illinois stand out as areas of low density, though not as low as the Cut-Over or the Great Plains.

The largest area with a density of over 15 units per 100 acres covered most of Iowa, except for the rougher section in the extreme south central and southeastern part of the state, and extended into adjacent parts of northwestern Missouri, southeastern South Dakota, southern Minnesota and Wisconsin, and northwestern Illinois. Sizable blocks over 15 were found in north central, central, and east central Indiana, as well as southwestern Ohio, and northeastern Nebraska. This pattern does not coincide with any of our established agricultural regions. A large portion of the Corn Belt did not contain such high densities. Much of the western part in Nebraska and South Dakota, and portions of northern Missouri and central and eastern Illinois were notable exceptions. In addition, this area with a density over 15 extended beyond the limits of the Corn Belt to include much of the southern part of the dairy region in central and eastern Minnesota and southern and eastern Wisconsin.

Concentrations of over 25 units per 100 acres were limited almost entirely to two small blocks in the livestock feeding areas of northwestern and east central Iowa.

The general pattern of livestock density offers few surprises. High concentrations such as those just cited for Iowa were known at least to some extent. Low concentrations in the cash-grain areas of Illinois and west north-central Iowa, and such places as the sand plain of central Wisconsin could have been predicted, yet the tremendous

[9] See W. D. Jones: "Ratios and Isopleth Maps in Regional Investigation of Agricultural Land Occupance," *Annals Assn. of Amer. Geogrs.*, Vol. 20, 1930, pp. 177–195.

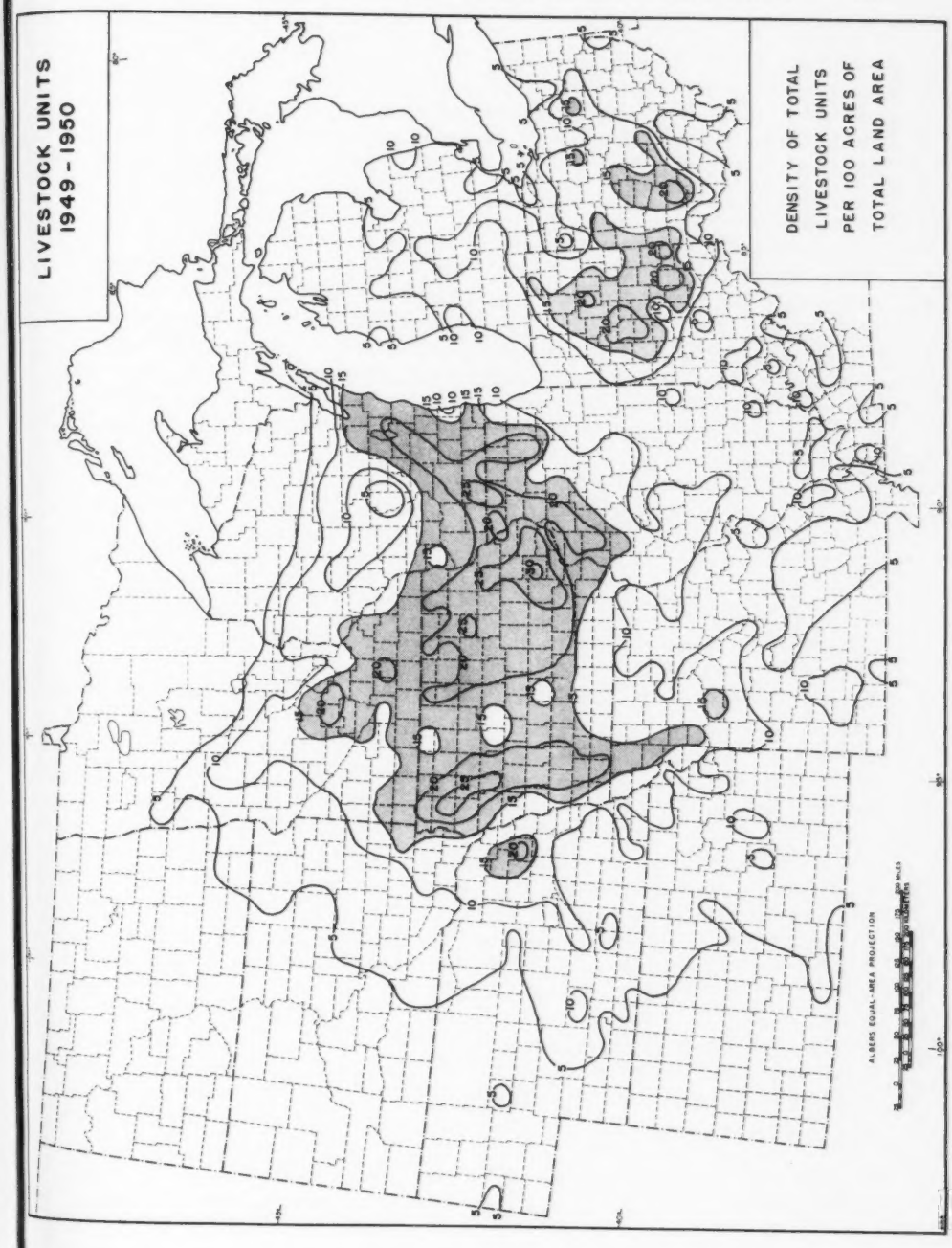

LIVESTOCK UNITS
1949 - 1950
DENSITY OF TOTAL
LIVESTOCK UNITS
PER 100 ACRES OF
TOTAL LAND AREA
ALBERS EQUAL-AREA PROJECTION

FIG. 1.

variations within the limits of the traditional "meat producing Corn Belt" are not generally included in the literature on the area. In the central part of the Corn Belt densities varied from as low as seven units to as high as 31 units per 100 acres of land area. Within Iowa alone they varied from 11 to 31, in Corn Belt northern and central Illinois from 7 to 27, in Indiana from 2 to 24, and in Ohio from 2 to 21. There were at least four definite "ridges" and "valleys" in the livestock density pattern across the Corn Belt region from eastern Nebraska to central Ohio. There was no real homogeneity in densities within the limits of this area which is so frequently used as a good example of a region and described as an area where the crops are fed to livestock being raised for meat.

LIVESTOCK VERSUS CROPS

Additional background information which will be helpful when viewing the relative position of each animal type within the total livestock picture is their comparative strength in relation to crops. The per cent of gross farm sales derived from livestock and livestock products (Fig. 2) gives this picture. The greater strength of wheat in North Dakota and Kansas compared to South Dakota and Nebraska is well marked. The grazing areas of the North Dakota Badlands, the Nebraska Sand Hills, and the Flint Hills of Kansas are exceptionally well defined. Outward trending gradients from these areas are often very steep indeed, especially on the southwest edge of the Sand Hills. The gradient between the cash-crop area of the Red River Valley and the livestock economy to the east is extremely impressive. Perhaps the steepest gradient of all is found between the cotton lands of the alluvial valley of the Mississippi in southeastern Missouri and the adjacent Ozark uplands. The cash-grain area of Illinois is obvious, with the per cent of gross sales derived from livestock and livestock products as low as 25 per cent in one county. The cash-crop district of Iowa, while not as pronounced as that of Illinois, is easily discernible, with percentages varying from 50 to 91 within a distance of three counties. The high value production of vegetables around large urban centers is quite noticeable with its accompanying relative weakness of livestock. Specialty areas, such as the potato region in and around Oneida County in north central Wisconsin, and the areas of fruits and other specialty crops in Michigan stand out sharply. A portion of the bed of glacial Lake Maumee in northwestern Ohio is another cash-crop area of small size.

Percentages of sales derived from livestock and livestock products ran high in the grazing regions of the Great Plains, in those portions of the Corn Belt where beef or hog raising or feeding was important, in the Great Lakes dairy region except where specialty crops overshadowed the dairying, in the Ozark Uplands, and in several spots along the Ohio River and in the Appalachian Plateau of eastern Ohio. In each of these areas the per cent derived from livestock and livestock products exceeded 90 in certain counties, and frequently in sizeable blocks of counties.

LIVESTOCK RANKS

The pattern found on the map of first ranking livestock type is amazingly simple (Fig. 3). The boundary between the area where dairy ranked first, in Minnesota, Wisconsin, and Michigan, and where hogs ranked first, in southwestern Minnesota, Iowa, Illinois, Indiana, and western Ohio, is very regular and approximately where one would expect to find it. However, the pro-

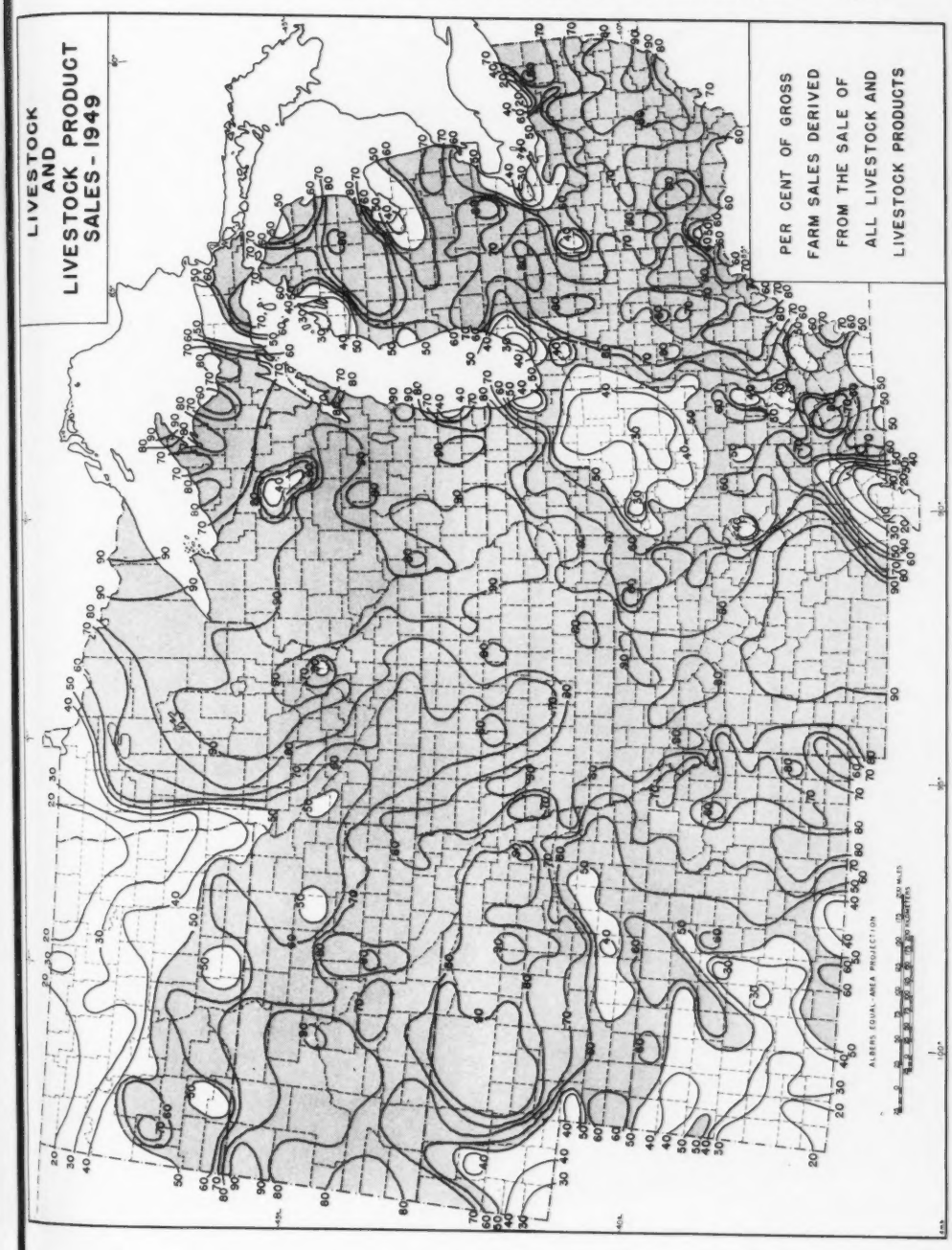

LIVESTOCK AND LIVESTOCK PRODUCT SALES - 1949
PER CENT OF GROSS FARM SALES DERIVED FROM THE SALE OF ALL LIVESTOCK AND LIVESTOCK PRODUCTS
ALBERS EQUAL AREA PROJECTION

FIG. 2.

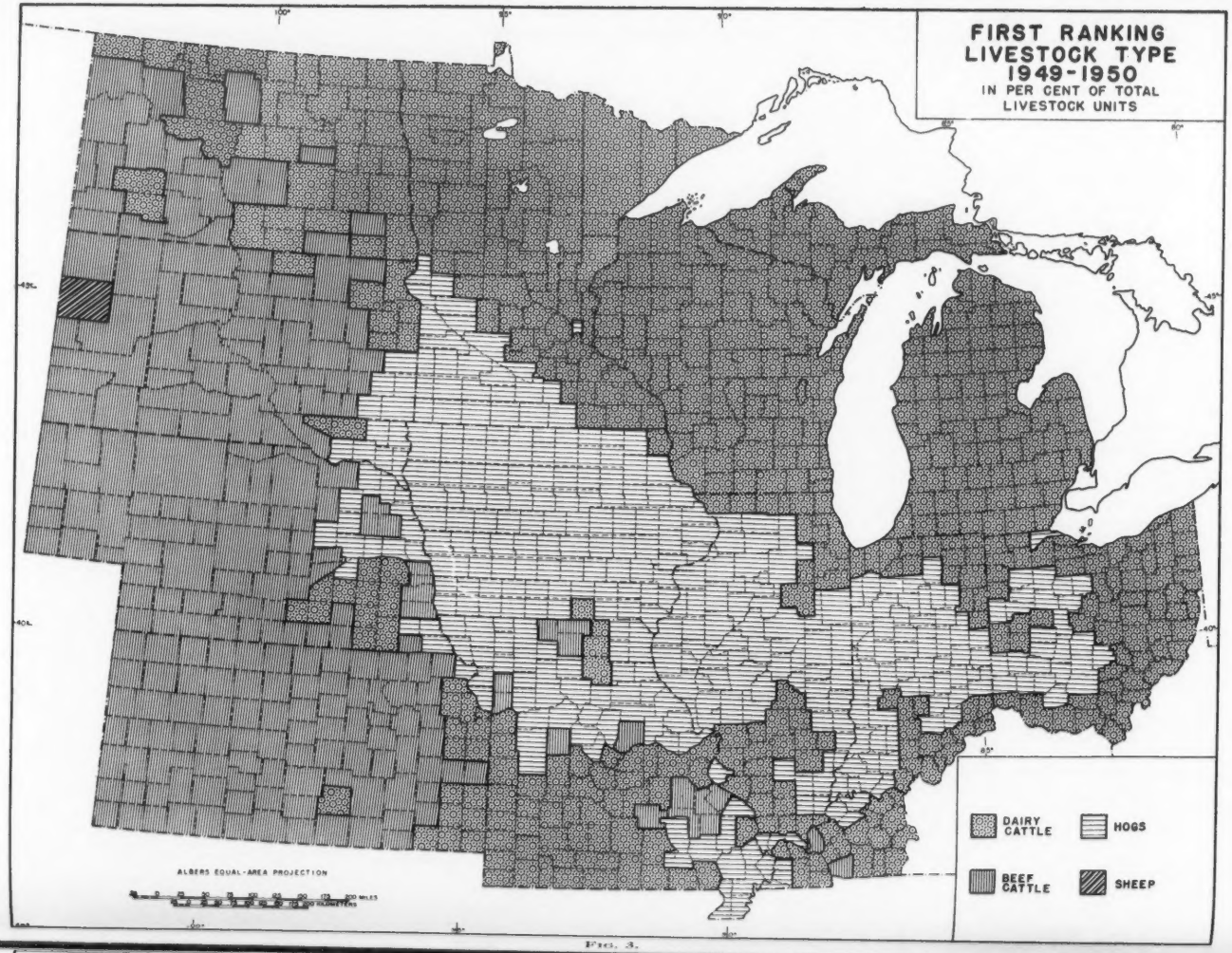

FIRST RANKING
LIVESTOCK TYPE
1949-1950
IN PER CENT OF TOTAL
LIVESTOCK UNITS
DAIRY CATTLE
HOGS
BEEF CATTLE
SHEEP
ALBERS EQUAL-AREA PROJECTION
100°
95°
90°
85°
80°
45°
40°

FIG. 3.

SECOND RANKING

SECOND RANKING
LIVESTOCK TYPE
1949-1950
IN PER CENT OF TOTAL
LIVESTOCK UNITS
DAIRY CATTLE
BEEF CATTLE
SHEEP
HOGS
CHICKENS
TURKEYS
SECOND RANK UNDER ONE PER CENT
ALBERS EQUAL AREA PROJECTION

FIG. 4.

jections and islands of dairy cattle in first rank within the Corn Belt indicate a strength of dairying in this region that is seldom if ever described. The position of dairy cattle in first rank in much of North Dakota is perhaps best explained by the general low density of livestock of all types, and the presence of dual-purpose cattle.

The ranking of hogs ahead of beef cattle throughout almost the entire Corn Belt with the exception of parts of eastern Nebraska and northern Missouri bears testimony to the efficiency of hogs as users of feed, and also to generally higher returns for labor input than are derived from other livestock types. As would be expected, beef was the leading category in practically all the Great Plains section with the somewhat surprising exception of much of North Dakota. Sheep ranked first only in Butte County, South Dakota. No other livestock type had sufficient strength to attain a place on this map.

Understandably, the second rank pattern is more complex (Fig. 4). Hogs were in second place in an almost continuous belt around the main area in which they ranked first, but the central district in which they did rank first is divided on the second rank map between beef and dairy. Dairy cattle were a rather poor second in much of the Great Plains section. Sheep were second in several western Dakota counties, in one county in the hilly portion of northern Missouri, and in one county in northern Minnesota. Chickens were a weak second in much of the Cut-Over, but had a respectable strength in other sections of Michigan and Ohio. Turkeys were a poor second in three northern counties in Minnesota and Michigan.[10]

[10] No livestock type accounting for less than one per cent of the total was included in the calculations. For that reason Armstrong County, South Dakota, shows no second rank.

The third rank map (Fig. 5), though perhaps more fragmented than the second rank map, still displays a tendency to rather large blocks. This map shows hogs in another almost continuous concentric band outward from the second place area. Dairy and beef have exchanged their second rank positions in the central portion of the map, and chickens reached this rank in large districts and over considerable portions of the Dairy Belt as well as in certain eastern and southern parts of the region.

The lack of fragmentation on the fourth rank map (Fig. 6) is rather startling at first glance. Chickens held this rank for much of the area, in fact almost all of the region where they did not hold a higher rank. The general tendency for dairy cattle, hogs, and beef cattle to be the major types of livestock means that this trio occupied the first three ranks over much of the region. While chickens were a less important type of livestock than the three just mentioned, they did not have much competition for fourth rank when considering the Midwest as a whole. Only in very limited areas did sheep, turkeys, or ducks reach sufficient strength to challenge any of the four leading types for one of the top ranking positions.

The simple patterns of the first and fourth rank maps make a generalized understanding of the relative position of the livestock types rather easy. The second and third rank maps, however, require more detailed study.

MAJOR LIVESTOCK TYPES

The five major livestock types (see footnote 2) are shown according to their relative strengths in Figures 7, 9, 10, 11, and 13. Let it be emphasized once again that each of these maps must be viewed with reference to the density map (Fig. 1) if a feeling for absolute strength

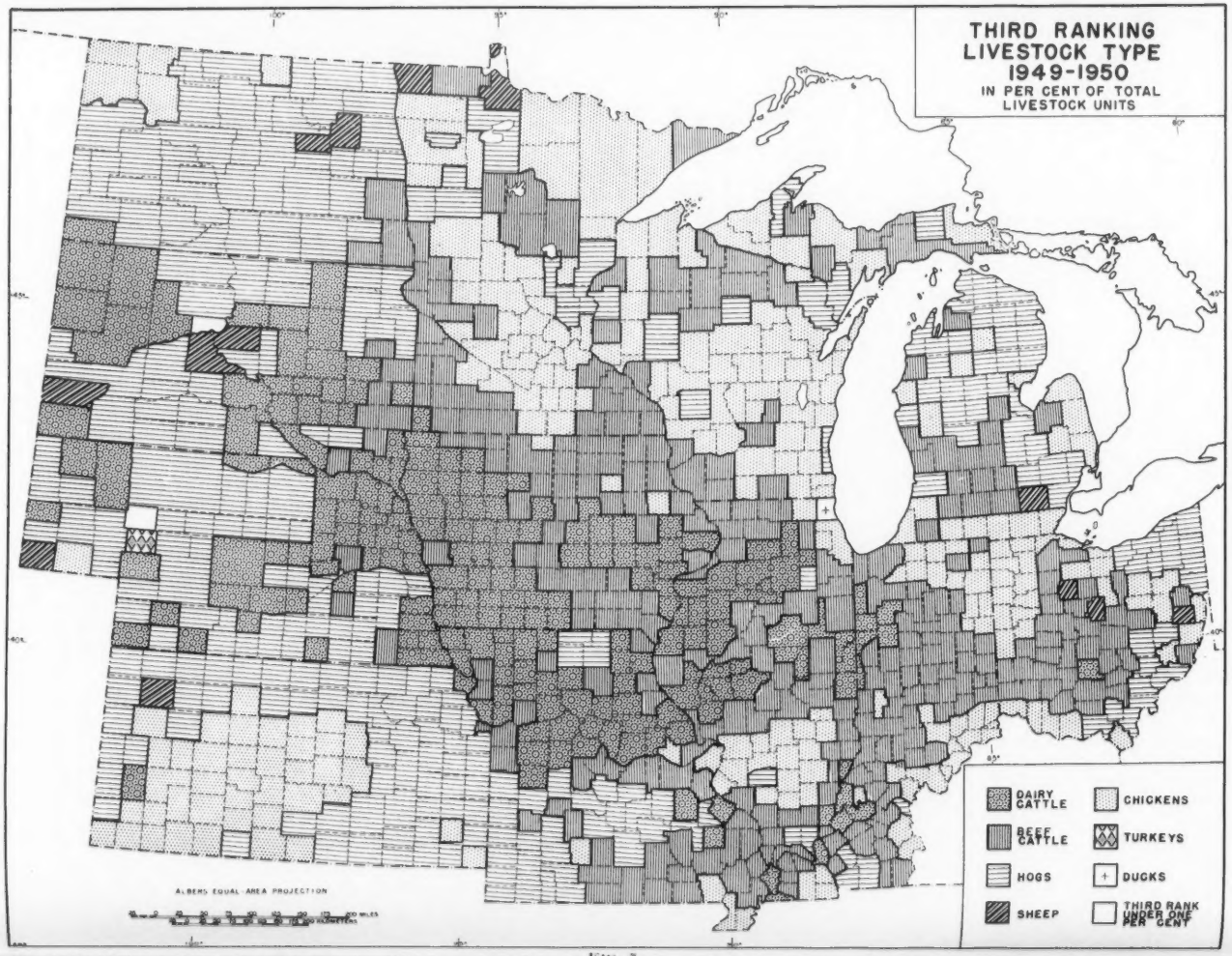
is desired. Also, one should keep in mind the different methods used to arrive at the number of units of the several kinds of livestock. Where possible, maps of per cent of gross farm sales derived from the separate categories have been added to help verify the patterns as revealed by units.[11]

Dairy cattle exhibited a greater strength over a larger portion of the map than any other animal (Fig. 7). Areas with less than 30 per cent of the total livestock units represented by dairy cattle were limited almost entirely to the Great Plains and the Prairie Peninsula heart of the Corn Belt, whereas areas under 10 per cent of the total were limited to the grazing districts of western South Dakota and northwestern Nebraska and to isolated spots in southwestern Kansas. The great relative strength of dairying showed up in the traditional Dairy Belt of Minnesota, Wisconsin, and Michigan where percentages were consistently over 50, with much of it over 60 and even 70, and with several counties over 90 per cent. The rather new dairy region of the Springfield area in southwestern Missouri is quite evident with percentages ranging as high as 74 in Webster County. Dairy unit percentages were quite high also in much of North Dakota and the Ohio Valley, but on the dairy sales map (Fig. 8) these areas do not appear strong because income from both crops and livestock were included within the total. The gradients on both maps confirm the regions of concentration of dairy strength in the Great Lakes area and southwestern Missouri. Figure 8 tends to eliminate areas where crops are dominant such as those mentioned above in North Dakota and the Ohio Valley, and even shows the much greater significance of crops in Michigan than in Wisconsin (see Fig. 2). Districts of crop specialties such as the potato area of northern Wisconsin, as noted above, make islands within the dairy region on the map showing per cent of gross sales. These islands are not as well defined on the dairy units map, but even there they usually can be detected.

Figure 9 presents a simple pattern for the area of greatest strength in hogs. The isopleth representing 30 per cent of total livestock units approximates the limit of hogs in first rank. The main districts over 50 per cent of the total occur in a zone extending from northwestern Iowa to southwestern Ohio, interrupted by a corridor of lower ratios coincident with the cash-grain area of eastern Illinois. The highest percentages on the map, slightly over 70, are found in southeastern Indiana. The association of hog production with regions producing large quantities of concentrated feeds such as corn, rather than bulky feeds such as hay or forage crops, is well marked.

The portions of the mapped area where beef cattle reached a position of 50 per cent or more of total livestock units is limited entirely to the Great Plains (see Fig. 10). Percentages exceeded 90 in many counties and approached 100 in Armstrong County, South Dakota, and in Grant County, Nebraska. Again the grazing lands of the North Dakota Badlands, southwestern South Dakota, the Nebraska Sand Hills, the Flint Hills of Kansas, and isolated spots in western Kansas are quite obvious. The beef feeding areas of western and eastern Iowa and northern Illinois showed percentages over 30. Figures just as high, and even occasionally over 40, were found in the beef raising districts of southern Iowa and much of Missouri. The active program

[11] Value categories for livestock types in the census are as follows: a. dairy products, b. poultry and poultry products, and c. livestock and livestock products other than dairy and poultry.


THIRD RANKING
LIVESTOCK TYPE
1949-1950
IN PER CENT OF TOTAL
LIVESTOCK UNITS
DAIRY CATTLE
BEEF CATTLE
HOGS
SHEEP
CHICKENS
TURKEYS
DUCKS
THIRD RANK UNDER ONE PER CENT
ALBERS EQUAL-AREA PROJECTION
FOURTH RANKING

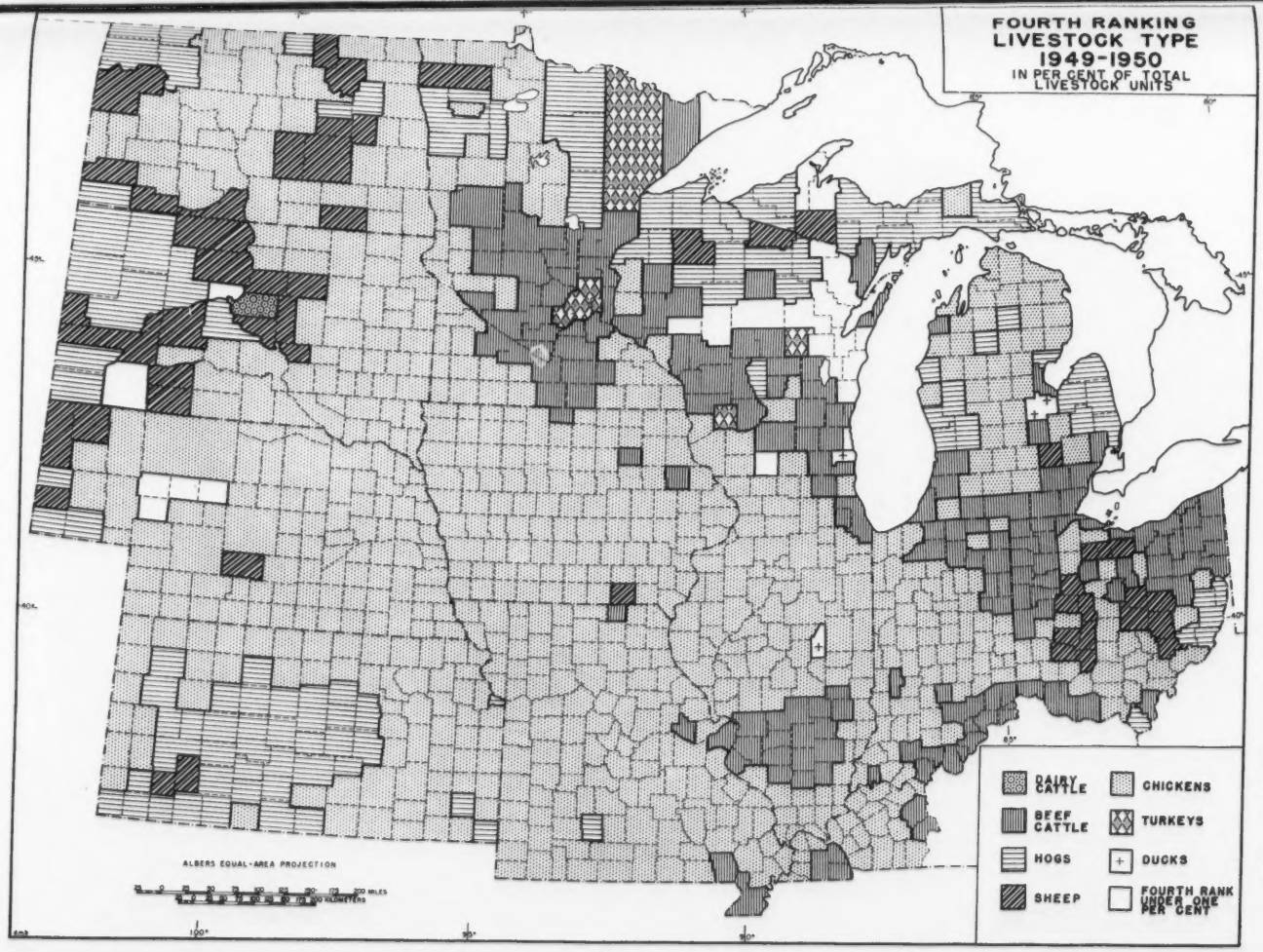
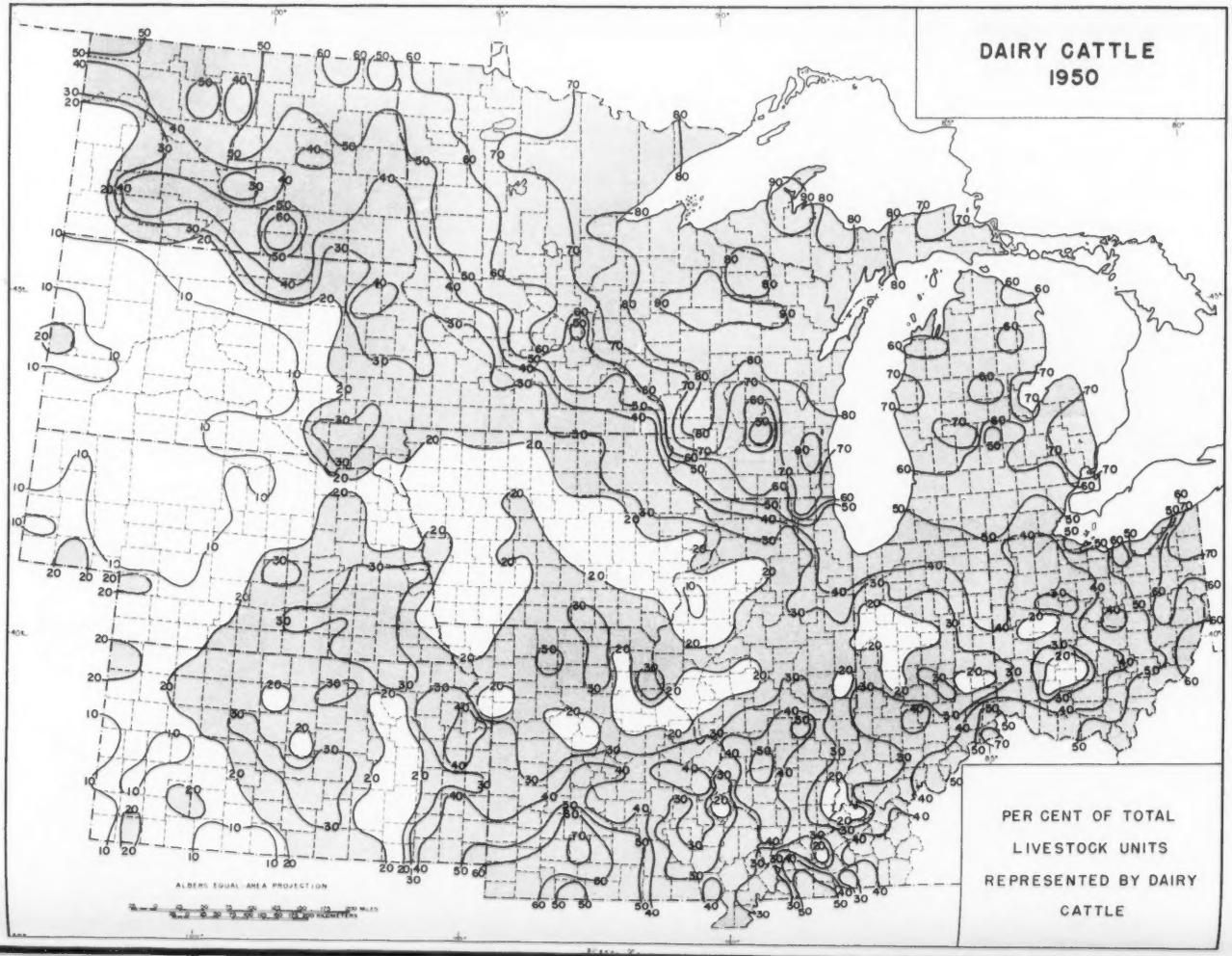

FOURTH RANKING
LIVESTOCK TYPE
1949-1950
IN PER CENT OF TOTAL
LIVESTOCK UNITS
DAIRY CATTLE
BEEF CATTLE
HOGS
SHEEP
CHICKENS
TURKEYS
DUCKS
FOURTH RANK UNDER ONE PER CENT
ALBERS EQUAL-AREA PROJECTION

FIG. 6.


DAIRY CATTLE
1950
PER CENT OF TOTAL
LIVESTOCK UNITS
REPRESENTED BY DAIRY
CATTLE
ALBERS EQUAL AREA PROJECTION

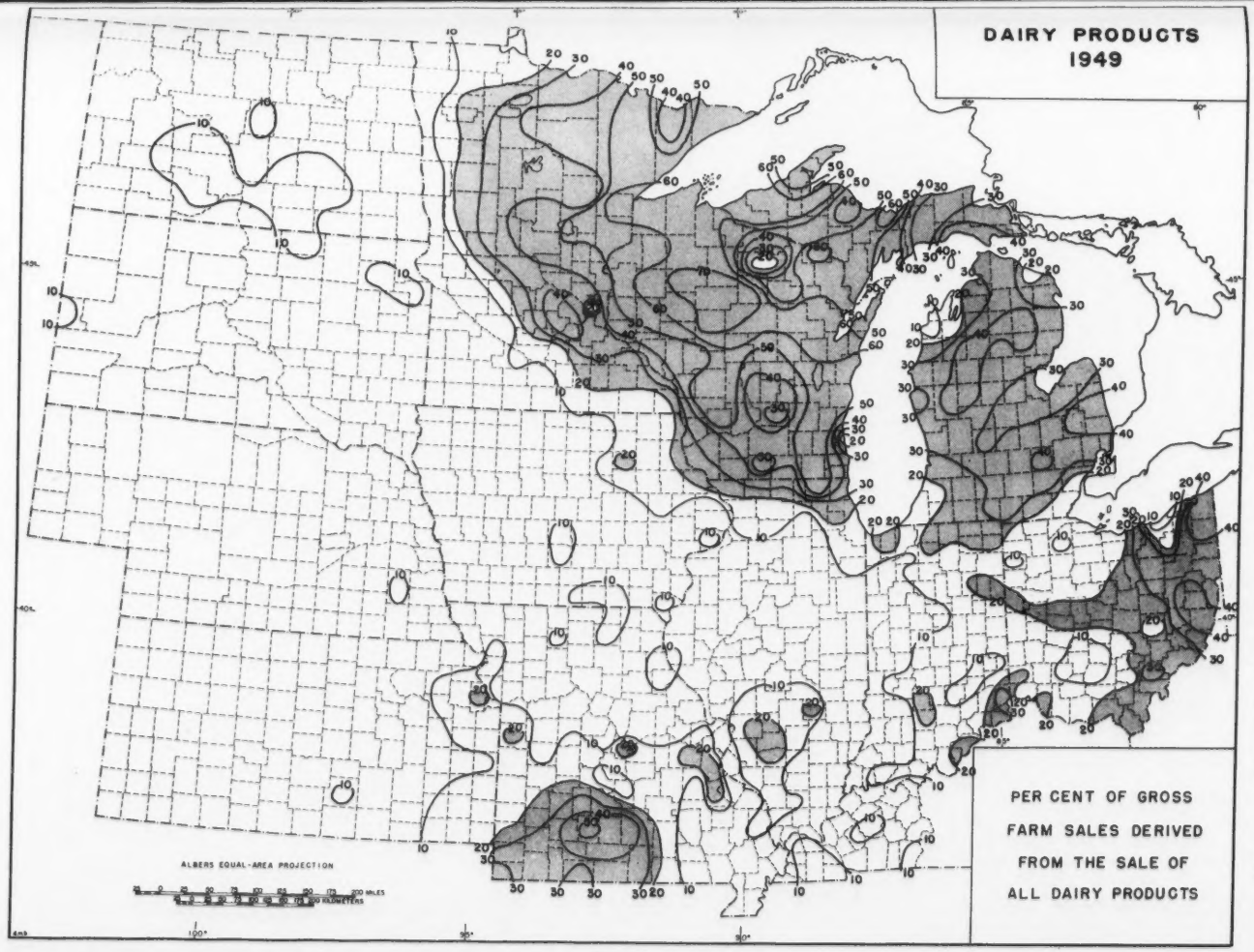

DAIRY PRODUCTS
1949
PER CENT OF GROSS
FARM SALES DERIVED
FROM THE SALE OF
ALL DAIRY PRODUCTS
ALBERS EQUAL-AREA PROJECTION

FIG. 8.

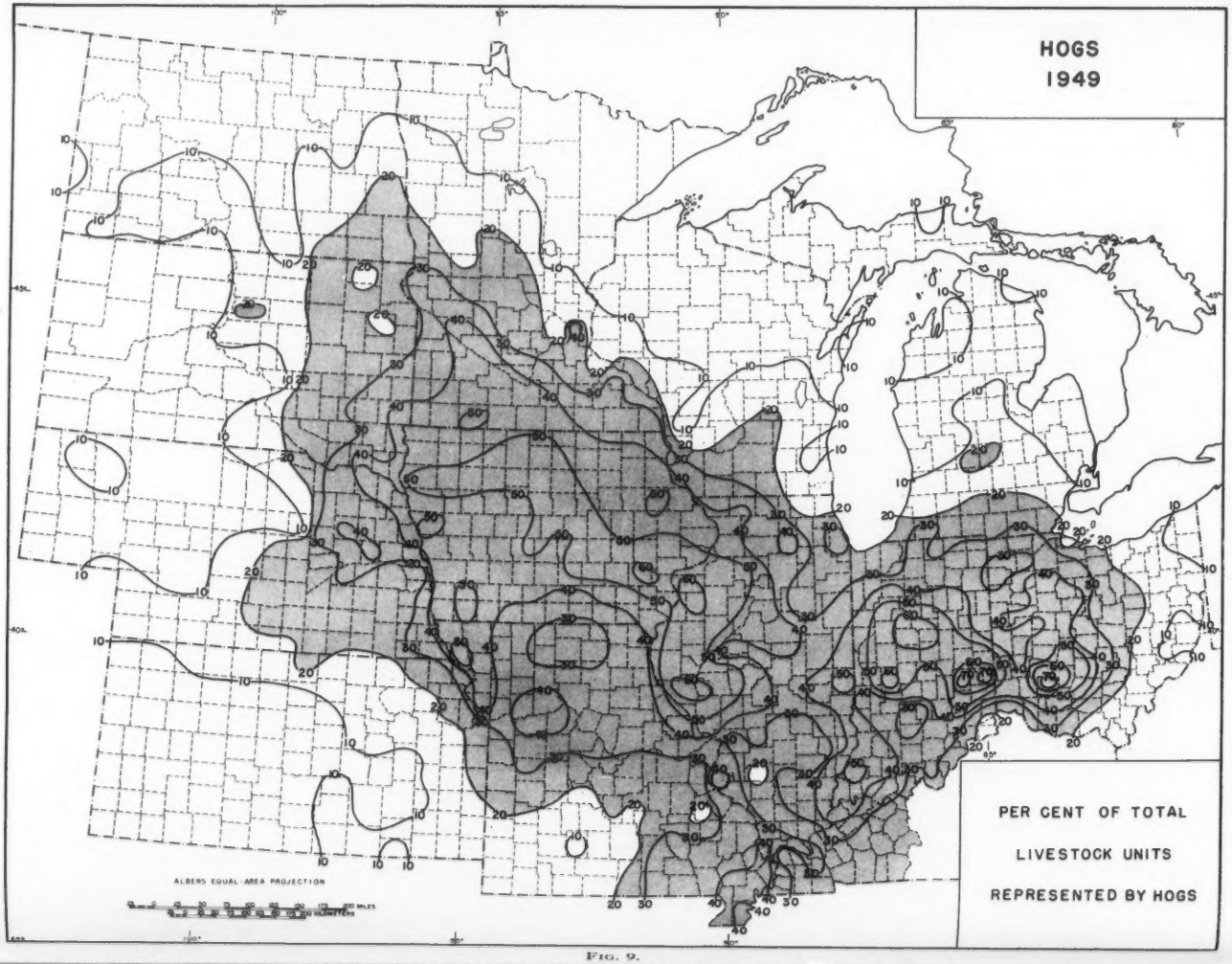

HOGS
1949
PER CENT OF TOTAL
LIVESTOCK UNITS
REPRESENTED BY HOGS
ALBERS EQUAL-AREA PROJECTION

FIG. 9.

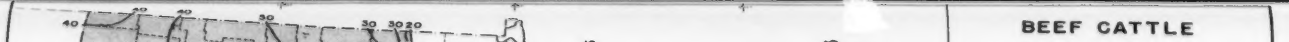

BEEF CATTLE

FIG. 9.

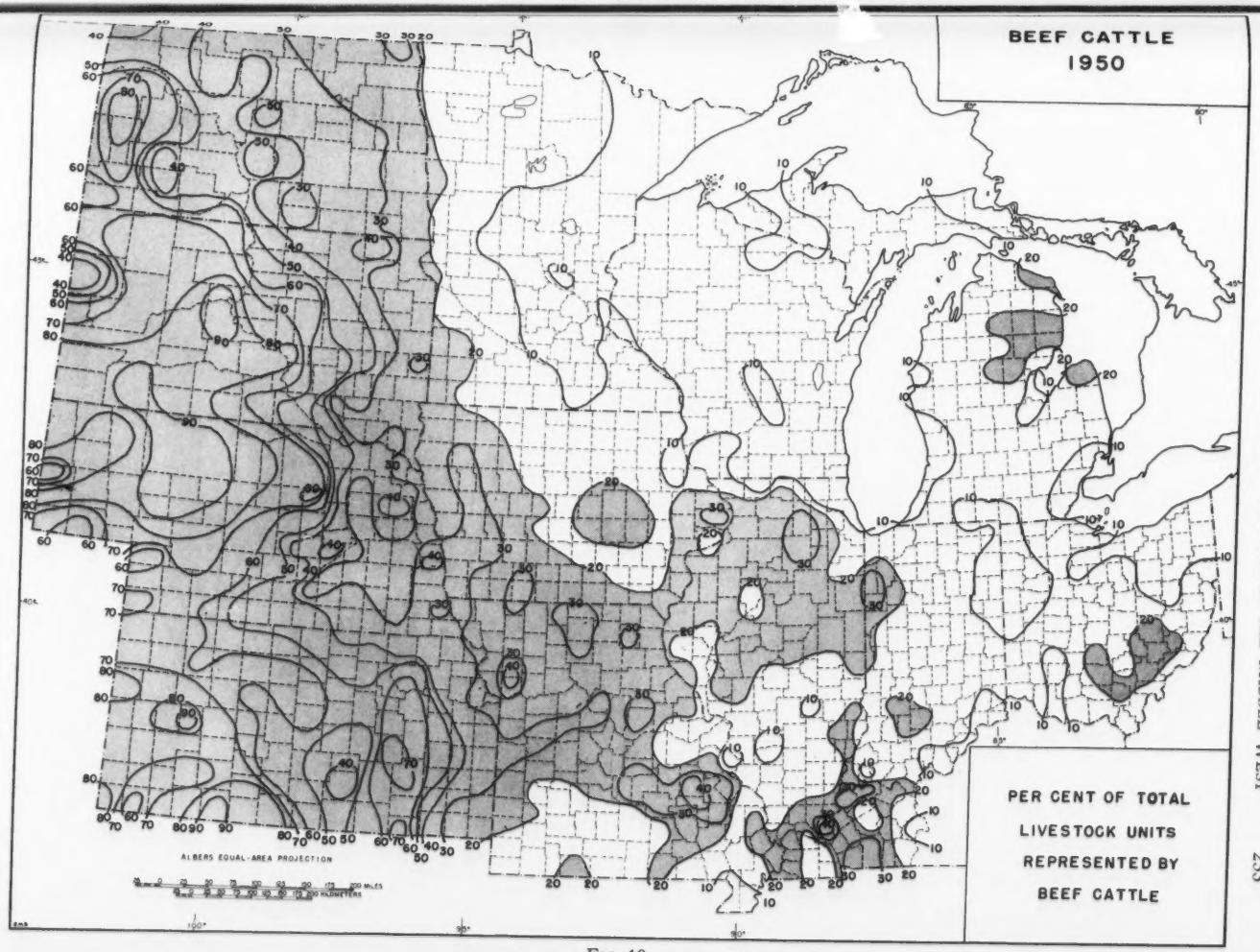

BEEF CATTLE
1950
PER CENT OF TOTAL
LIVESTOCK UNITS
REPRESENTED BY
BEEF CATTLE
ALBERS EQUAL-AREA PROJECTION

FIG. 10.

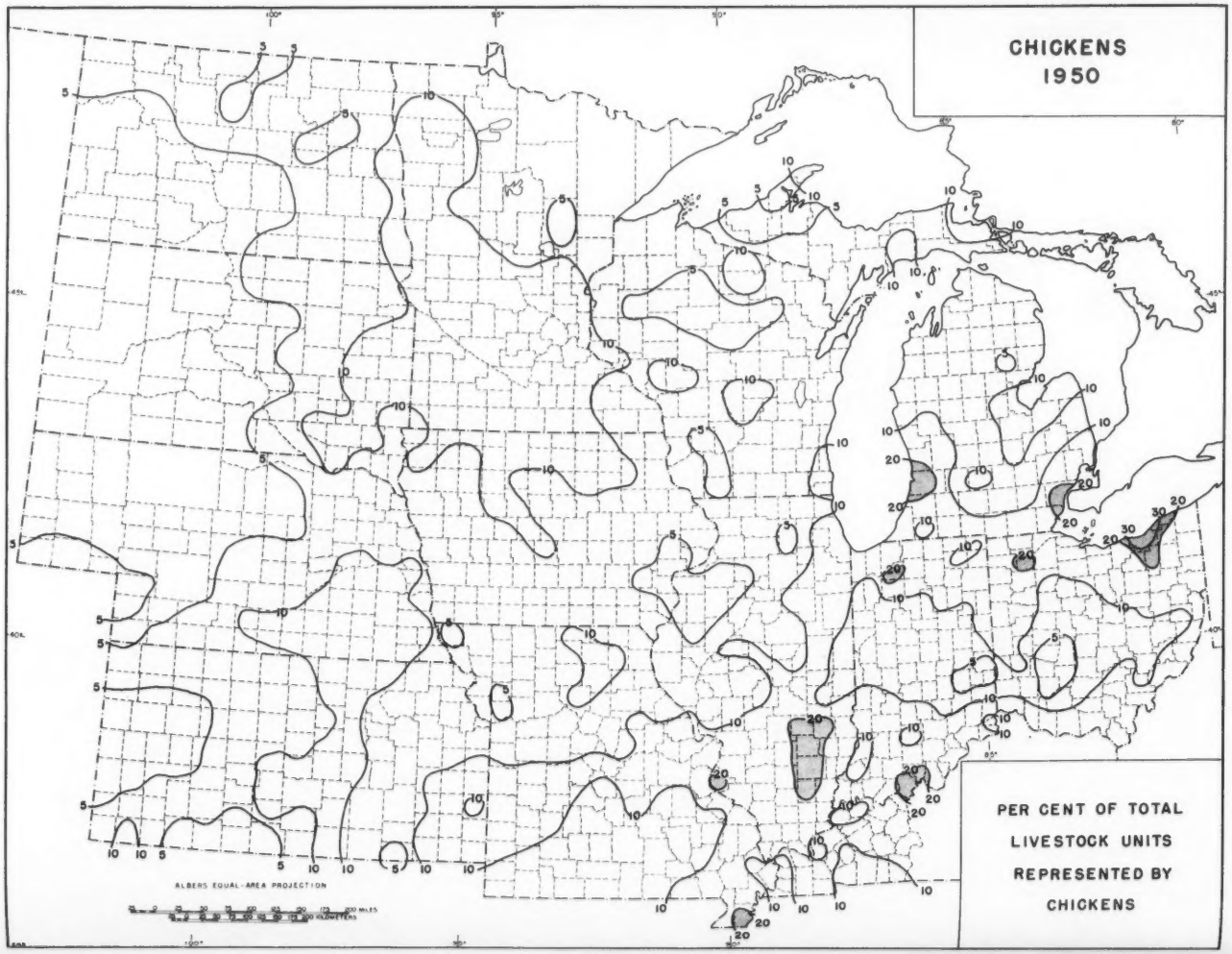

CHICKENS
1950
PER CENT OF TOTAL
LIVESTOCK UNITS
REPRESENTED BY
CHICKENS
ALBERS EQUAL-AREA PROJECTION

FIG. 11.

POULTRY AND POULTRY
PRODUCTS

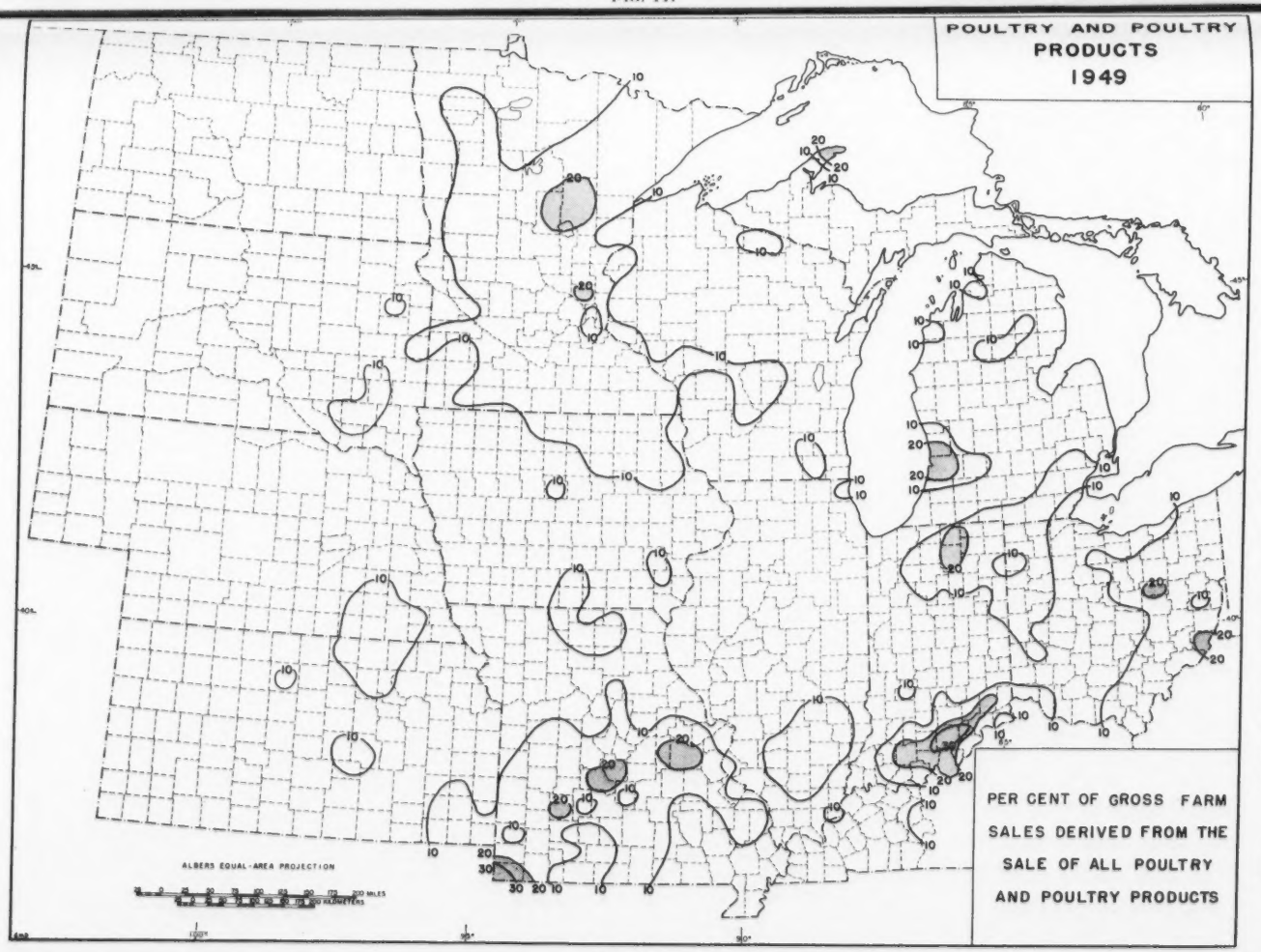

POULTRY AND POULTRY PRODUCTS 1949
PER CENT OF GROSS FARM SALES DERIVED FROM THE SALE OF ALL POULTRY AND POULTRY PRODUCTS
ALBERS EQUAL-AREA PROJECTION

FIG. 12.

on the part of the Missouri Agricultural Extension Service to increase grassland acreages and to improve them through seeding and the application of fertilizer may account for beef cattle percentages running over 20 for most of the state, and in large sections over 30. No other state east of the Great Plains exhibited such a large area over 20 per cent. Beef feeding and beef raising did combine, however, to make significant sections of Iowa and Illinois exceed this figure.

Nowhere in the mapped area did chickens exceed 25 per cent of the total livestock units except in the immediate vicinity of Cleveland where they just reached 30 (Fig. 11). Areas over 20 per cent were limited indeed, and major districts over 10 per cent were found only in Minnesota and bits of adjacent states, a strip from southeastern Nebraska south across Kansas just west of the Flint Hills, and a band which extended from southeastern Kansas to eastern Ohio and southern Michigan. The poultry sales map (Fig. 12) is of less utility than the dairy sales map in validating the patterns determined by units because all types of poultry were included. Areas of high income from poultry were roughly coincident with the high unit areas, but the sales percentages often exceeded unit percentages by a significant amount. This could be due in part to other types of poultry, but it should be remembered that sales figures are based on gross sales and do not necessarily reflect net returns. As both the fourth rank map (Fig. 5) and the chickens unit map (Fig. 11) indicate, chickens were a rather ubiquitous minor element, but never reached the dominant position attained by dairy cattle, beef cattle, or hogs.

Figure 13 emphasizes the present, restricted nature of sheep raising in the Midwest. The greatest relative strength was found in northwestern South Dakota and this accounts for that region having lower beef percentages than the areas either to the north or the south. Smaller and less significant areas were found in the irrigated Scotts Bluff district of western Nebraska, the rougher lands of southern Iowa and northern Missouri, and in eastern Ohio. In a large portion of the map sheep did not account for even one per cent of the livestock units, and areas over 5 per cent are extremely limited.

LIVESTOCK COMBINATIONS

It is a more common practice for a Midwestern farmer to raise several types of livestock than it is for him to produce a single type. To be sure there may be many cattle ranches on the Great Plains that produce only beef cattle. There is also a trend in poultry farming to operate on a large scale and produce nothing but a single type of bird. By and large, however, the concentration on a single type of livestock is not typical. Dairy farmers in the main dairy regions are likely to raise some chickens and usually hogs are a part of the association. The raising or feeding of hogs and beef cattle on the same farm certainly is not uncommon, and these may be accompanied by a sizeable flock of chickens and quite possibly some dairy production as well. Because these many types are so frequently raised in associations involving two or more categories, livestock-combination regions, similar to the crop-combination regions, have been determined.

A continuing conviction is held that the statistical method used in the crop-combination studies is not completely satisfactory. It must be made clear, however, that the results obtained from that method have proved very enlightening in defining the major "core" areas even though marginal districts

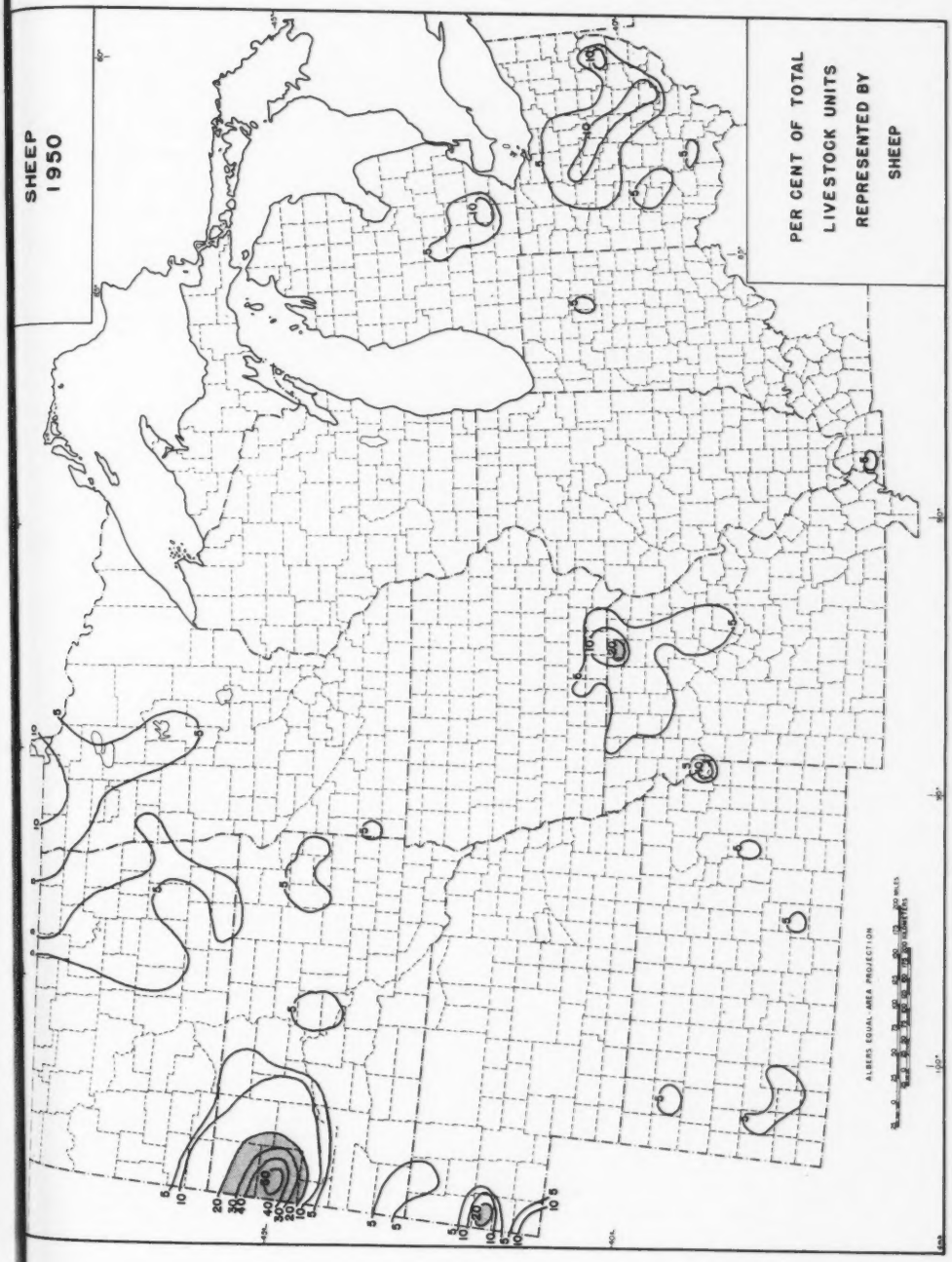

SHEEP
1950
PER CENT OF TOTAL
LIVESTOCK UNITS
REPRESENTED BY
SHEEP
ALBERS EQUAL AREA PROJECTION

FIG. 13.

may find a slight shift in boundaries when other methods are used. It should also be added that even though certain deficiencies in the method are now recognized, a great deal of subsequent thought and effort has so far failed to produce a completely desirable substitute method for defining the limits of these regions.

One of the main difficulties encountered when using this method for livestock combinations was found in areas where a given rank was marginal in strength. For example, in southern Indiana, most of the counties produced significant quantities of dairy cattle, hogs, and beef cattle with a percentage of chickens which in some cases would be included within the combination and in other cases would be excluded. Because the total deviation is affected by the position of all ranks, it is possible at times to exclude percentages in one rank which are stronger than those included at other times. To eliminate this inconsistency an arbitrary solution was developed to simplify the classification. In many of these marginal areas it appeared that the rank in question was approximately 50 per cent of the one above. For that reason a given rank item was included within the combination in these marginal situations if it accounted for more than 50 per cent of the rank above and was excluded if less than 50 per cent.[12]

This procedure simplified the classification, but often tended to fragment the area. It appears that the difficulty lies in trying to classify each county as one containing only whole number components when perhaps at times a county should be classified as having 2½ or 3½. For example, Greene County, Indiana—with percentages of hogs, 32%; dairy cattle, 31%; beef cattle, 23%; chickens, 12%; and sheep, 2%—needs a classification designation showing the three strong items and a fourth having less importance but being too strong to exclude. The fifth component, sheep, quite obviously is insignificant.

It has been considered proper to include a description of this variant procedure with the reasons for its use. It must be pointed out, however, that most of the counties were classified and the regions delimited by the same deviation method used in the crop studies. Therefore the combination regions map (Fig. 14) is comparable to the crop-combination regions map already published.

The basic livestock combination, if such there be, appeared to include H, B, and D.[13] Throughout the heart of the region this combination was extensive. In much of the area surrounding this block, chickens were added as a fourth component. Some of this four component combination was found in places where total livestock densities were low so that it became easier for chickens to reach a greater relative strength, but in parts of the area, such as northern Iowa and southern Minnesota, total livestock densities were

[12] For example, Pike County, Indiana—with livestock percentages of hogs, 46 per cent; dairy cattle, 21 per cent; beef cattle, 16 per cent; chickens, 11 per cent; and sheep, 1 per cent—was classified by the deviation formula as having four types of livestock. Martin County, Indiana—with percentages of hogs, 39 per cent; dairy cattle, 28 per cent; beef cattle, 20 per cent; chickens, 12 per cent; and sheep, 2 per cent—was classified as containing three types. On the map both are listed as having four types because the chickens in each case are more than half the third ranking item.

[13] For simplification here the same letters are used to represent the livestock types that are used in Figure 14, the Livestock-Combination Regions map. These symbols are: dairy cattle—D, hogs—H, beef cattle—B, chickens—C, and sheep—S. It should also be noted that the order of the symbols in a combination designation does not indicate rank order. Any county shown by the formula to contain dairy cattle, hogs, and beef cattle in any rank order would be listed as HBD.

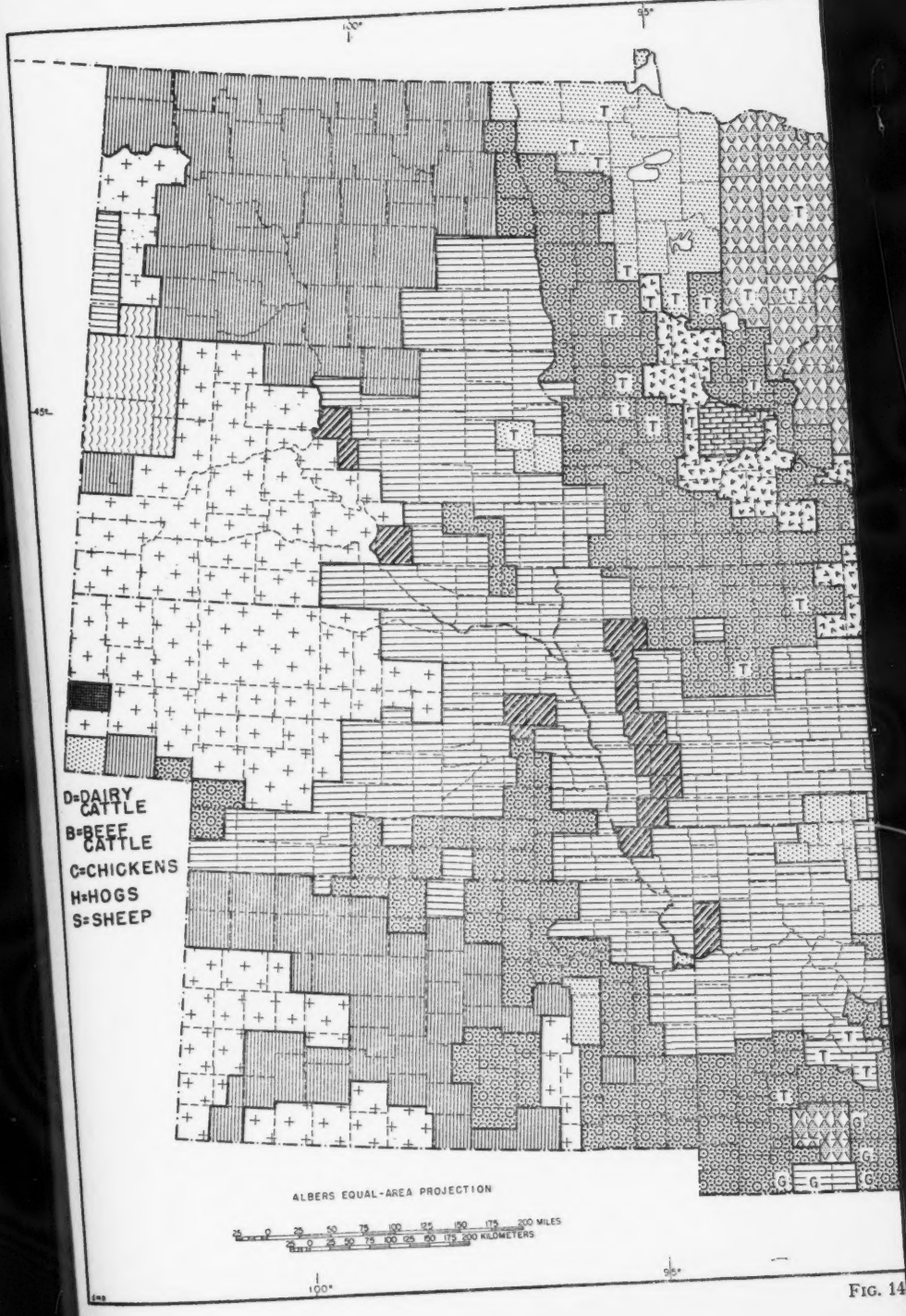

130°
95°
45°
D=DAIRY CATTLE
B=BEEF CATTLE
C=CHICKENS
H=HOGS
S=SHEEP
ALBERS EQUAL-AREA PROJECTION
25 0 25 50 75 100 125 150 175 200 MILES
25 0 25 50 75 100 125 150 175 200 KILOMETERS
100°
95°

FIG. 14

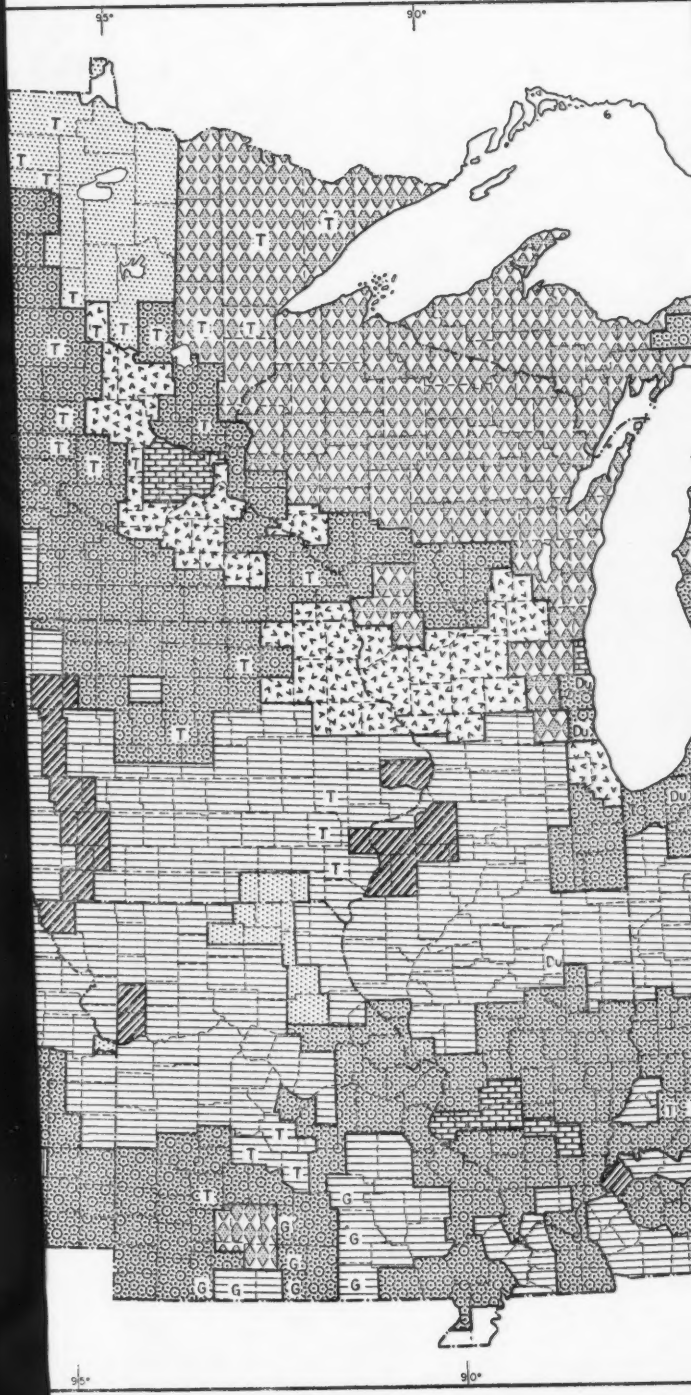
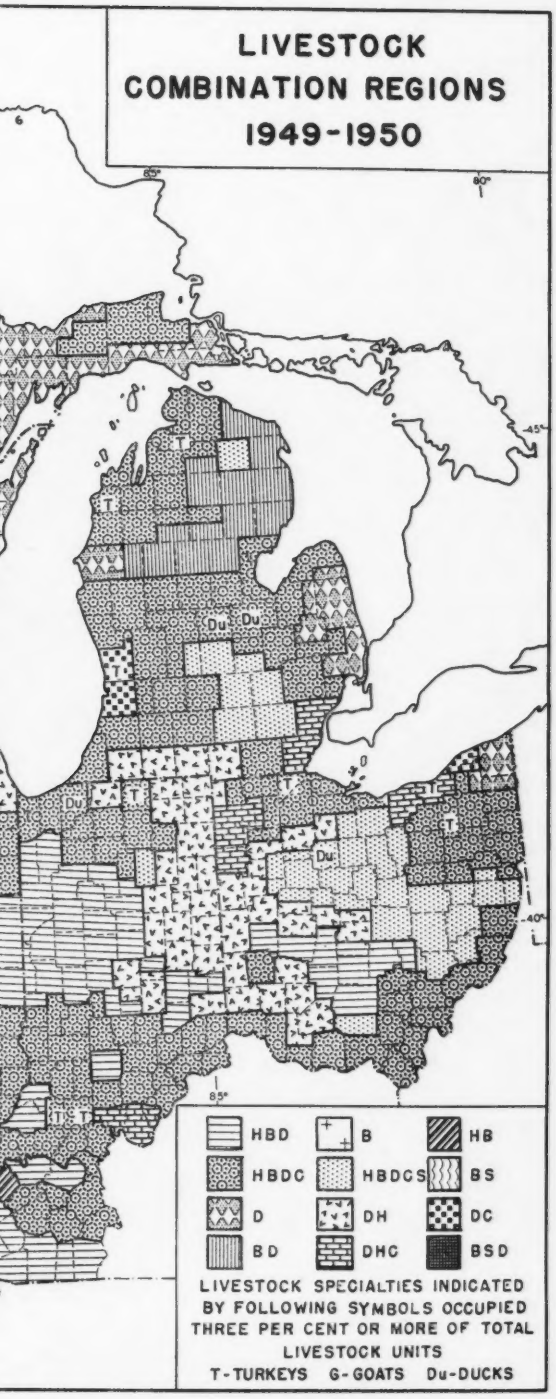


FIG. 14.


LIVESTOCK
COMBINATION REGIONS
1949-1950
85°
80°
45°
40°
85°
T
Du
HBD
B
HB
HBDC
HBDCS
BS
D
DH
DC
BD
DHC
BSD
LIVESTOCK SPECIALTIES INDICATED BY FOLLOWING SYMBOLS OCCUPIED THREE PER CENT OR MORE OF TOTAL LIVESTOCK UNITS
T-TURKEYS G-GOATS Du-DUCKS

relatively high and the absolute strength of chickens was considerable. In a few isolated places sheep gained sufficient strength to make a fifth component in the combination.

At the other extreme, areas were found with the single significant component of dairy cattle in parts of Minnesota, Wisconsin, and Michigan and bits of Illinois, Ohio, and Missouri, and the single component of beef in much of the Great Plains. In marginal positions between these single component areas and the three-element block in the center of the map, transitional districts existed which include only two of the basic components. Along the southern edge of the main Great Lakes dairy region were found areas of DH, and in parts east of the beef cattle area in Kansas and North Dakota were blocks of BD. HB was very limited and usually was associated with regions of heavy feeding. Four other combinations are found on the map, but the eight already mentioned account for over 97 per cent of the counties in the area.

Another way of analyzing this map is to note the extent of individual items. The first seven combinations shown on the map legend account for slightly over 95 per cent of the counties. Dairy cattle were found in all of these combinations except for the single-component beef cattle country of the Great Plains. Hogs were missing from the combinations in most of the northern and western portions of the mapped area in the D, B, and BD regions. Beef cattle were missing in only two of these seven combinations, D and DH, which were confined to the main dairy areas. Chickens were found in only two of these combinations but the extent of the four component combination, HBDC, with its many projections and far-flung extensions in all directions indicates the widespread nature of this somewhat minor element. Sheep were included in only one of these seven combinations, and even in the limited area of this association seldom do they occupy one of the higher ranks.

Were it not for the complicating factors of chickens, one would find most of the map, except for the northeast and west portions, having an HBD combination. Moving towards the northeast, first beef cattle and then hogs drop out as the single component dairy area is approached. Moving towards the west, first hogs and then dairy cattle disappear as the single component beef cattle region is approached. This generalized pattern is extremely simple even though the detailed regionalization on the map may not appear so.

CONCLUSION

In conclusion it seems fair to observe that while the use of livestock units and ratios as geographical tools is not new, they have been employed here in a revealing form to appraise the relative strengths and associations among the several livestock types. It is hoped that these new relationships will provide added insight concerning the basic structure of the Midwestern farm economy. Certainly the caution is justified that simplified generalizations such as a "Corn Belt" should always be subjected to critical examination lest one lose sight of existing ranges of variation.

THE CHANGING DISTRIBUTION OF SHEEP IN BRITAIN

John Fraser Hart

Dr. Hart is Assistant Professor of Geography at Indiana University. He spent the field seasons of 1949 and 1952 in Britain. *His travel in 1952 was financed by a grant from the University Center in Georgia.*

SHEEP have played an important role in British agriculture ever since the Middle Ages. In 1952 Britain ranked third in the world in terms of sheep density and tenth in terms of total sheep population. The 1952 population of 20,859,819 sheep represents an average of 42 sheep for every hundred persons in Britain, 46 sheep for every hundred acres of agricultural land, 26 sheep for each agricultural worker, and 48 sheep for every agricultural holding. Equally striking, however, is the fact that for every five sheep of the 1937–39 period there were less than four in the years 1950–52.

The 20 per cent decline in Britain's sheep population during the war and post-war period is an exaggeration of a trend which has continued irregularly since the first British agricultural returns were collected in 1866 (Fig. 1). If secular changes be disregarded, it appears that the British sheep population dropped from around 28 million in the 1870's to about 26 million between 1880 and 1910, and then to around 24½ million in the period 1925–39. Marked decreases in sheep numbers are associated with the two war periods, and the unusually severe winter of 1947 was responsible for a still further decline at a time when the post-war recovery had just gotten underway.

The decline in sheep population has not been uniformly distributed throughout Britain. Although national crises, such as wars and severe winters, affect the sheep population in Wales and Scotland as well as in England, the decline in numbers of British sheep over the last 75 years has been restricted largely to England, whereas the sheep population of Wales and Scotland has remained relatively stable or even increased slightly. It is the purpose of this paper to consider the changing distribution of sheep in Britain, the factors influencing the change, and some of the economic and political problems resulting from the change.

To understand the changing distribution of sheep in Britain one must first consider the interrelation of physical features and farming types (Fig. 3).[1] Although flocks of sheep are found on general mixed farms scattered throughout Britain, the majority of sheep are concentrated in three types of areas with distinctive physical environments and sheep farming economies:

(1) intensive sheep grazing on the rich alluvial pastures of Romney Marsh.

(2) grain (largely barley) and sheep production, with increasing emphasis on dairying toward the south, on the thin-soiled uplands of Cretaceous Chalk and Jurassic limestone which extend

[1] The classic study of farming types in pre-war Britain is contained in L. Dudley Stamp: *The Land of Britain, Its Use and Misuse*, Longmans, Green & Co., London, 1948, pp. 298–334; this study has been brought up to date for Scotland in Great Britain, Department of Agriculture for Scotland: *Types of Farming in Scotland*, H. M. Stationery Office, Edinburgh, 1952.

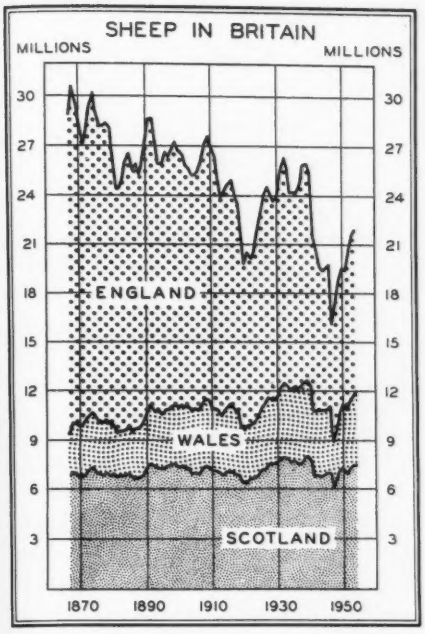


FIG. 1. Total number of sheep in Britain each year, 1866–1954.

diagonally across southeastern England.

(3) stock rearing and hill sheep farming in the bleak hill and mountain lands ("moorlands") of Highland Britain.

The change in sheep numbers in Britain is closely related to the type of farming. The stock rearing (including hill sheep farming) areas in Highland Britain had lost less than one quarter of their 1937–39 sheep numbers in 1950–52, and the sheep population of some counties had actually increased. At the other extreme, in the grain and sheep areas of southeastern England the sheep population had been halved within 15 years. For the most part, the counties which reported more than a quarter and less than half of their pre-war sheep population in 1950–52 are on the fringes of Highland Britain. The exceptions are to be found in the Midlands in areas dominated by beef cattle or by grain and sheep farming, and in the far southeast on Romney Marsh.

Britain's densest sheep concentrations in 1951 were in upland areas where sheep numbers have remained relatively stable during the war and post-war years (Fig. 2). Five counties in central Wales and two in southern Scotland had more than one sheep for every acre of agricultural land (including rough grazings), and both Brecon and Merioneth had more than 1⅓ sheep per acre. These areas of greatest density were fringed by counties with more than 7½ sheep for every ten acres, both in Wales and along the Border between Scotland and England. The majority of counties with more than 55 sheep per hundred acres were also in upland areas, but this category also includes the "Hunting Shires" in the eastern Midlands, which have the densest sheep population in

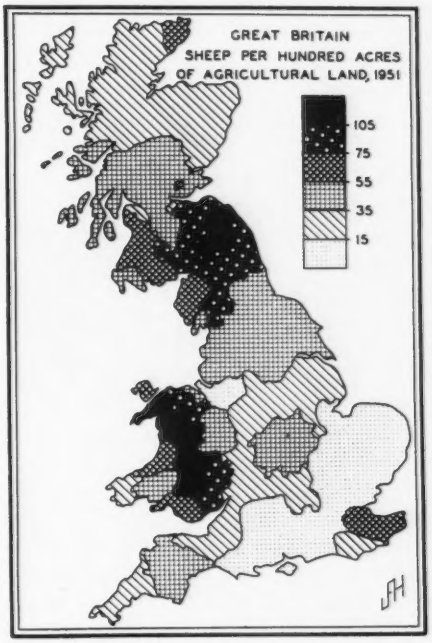


FIG. 2. Number of sheep per hundred acres of agricultural land (including rough grazings) in Britain, 1951.

Lowland Britain (if Romney Marsh be excluded). Counties with 15 to 35 sheep per acre are found in northern Scotland and in a very irregular belt extending across England from the Humber to Exmoor. With the exception of Cheshire, all the counties with less than 15 sheep per hundred acres are in southeastern England.

Comparison of changes in the sheep population with the present density emphasizes the differences between three broad areas in Britain (*Cf.* Figs. 2 and 3 and Table I). Southeastern England, including the Chalk and all land to the south and east, has less than half its pre-war sheep population, and densities generally less than one sheep for every ten acres of agricultural land. Midland England, between the Chalk outcrop and Highland Britain, has between a half and three quarters of its pre-war sheep totals, with densities ranging from one sheep for every five acres to one sheep for every two. Highland Britain is somewhat more complex. For the most part the sheep population has declined less than a quarter since 1939, and the density is greater than one sheep to two acres. Each of these three areas must now be examined to understand the factors which have influenced war and post-war changes and the resultant densities of today.

SOUTHERN AND EASTERN ENGLAND

The sheep population of southern and eastern England has dwindled sharply over the last 75 years (Fig. 4). The million and a quarter sheep south and east of the Chalk scarp in 1951 represented less than a fifth of the seven million which had been there in 1874. More than a third of the sheep in this area in 1951 were in Kent; if this county, which includes Romney Marsh, is removed from our calculations the remaining three quarters of a million sheep total only one-eighth of the six million in the corresponding area in 1874.

Except for Romney Marsh, the sheep of southern and eastern England have been concentrated on the Chalklands (Fig. 3). Sheep played an essential role in the farming system practiced on these thin-soiled Cretaceous limestone up-

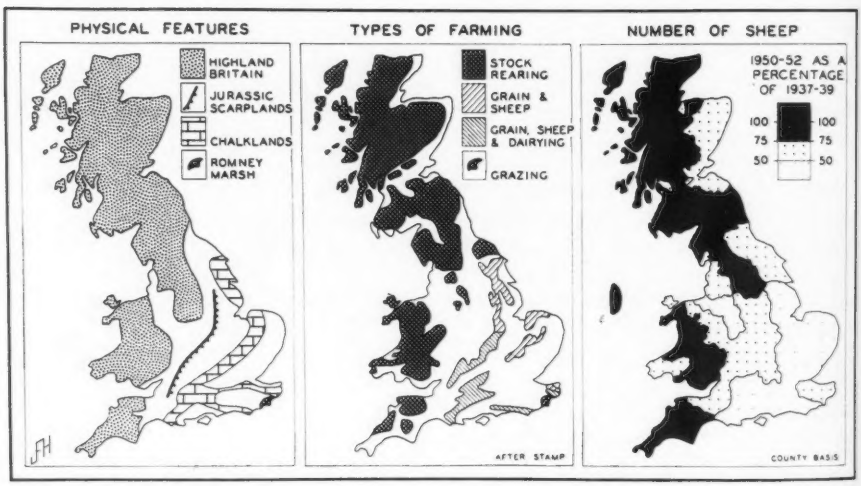


FIG. 3. Physical features, types of farming, and changes in sheep population between 1937–39 and 1950–52.

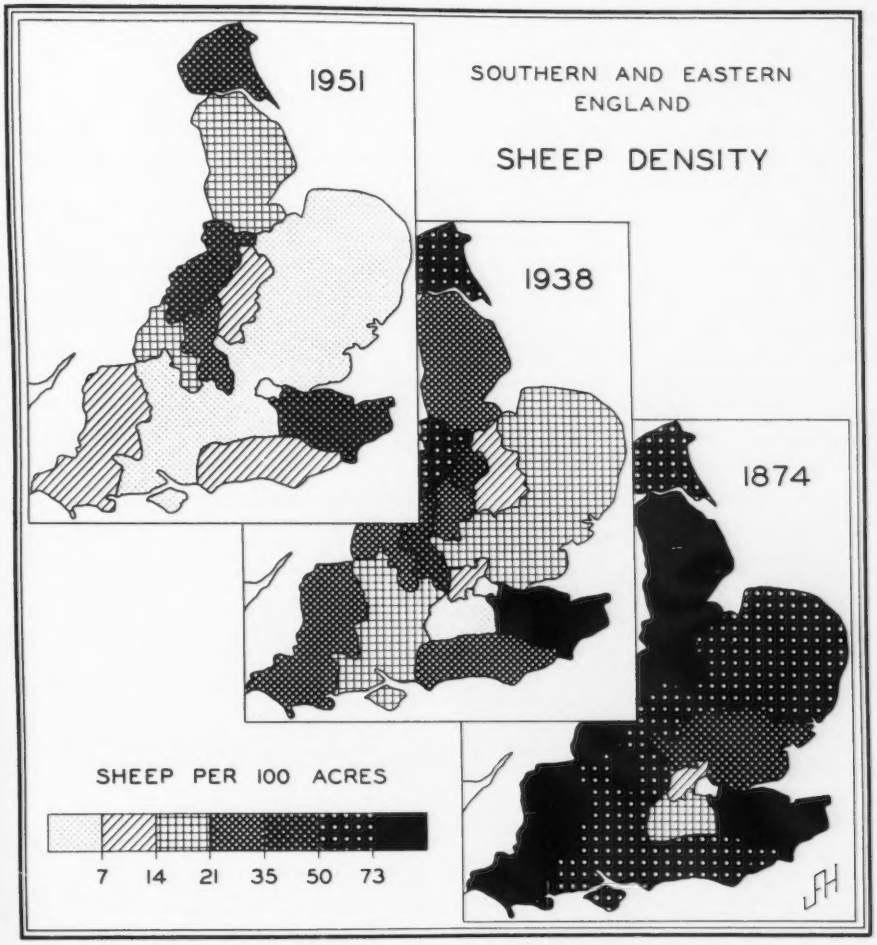


FIG. 4. Sheep density in southern and eastern England, 1874, 1938, and 1951.

lands.[2] The common "four-course" rotation consisted of fodder roots, barley, seeds (clover, sainfoin, peas, or beans), and wheat. The grain provided a cash crop, and the straw, roots, and seeds were used for fodder. Sheep were "folded" on roots in winter and on grain stubble underplanted with seeds in late summer and fall (Fig. 5).[3] Sheep enriched a soil of relatively low fertility with their droppings, and their hooves compacted the light soil when they were folded on roots. In areas of light soil there has been a strong tradition that sheep must be kept, even at a slight

[2] For a discussion of the agricultural system of the Chalklands, see Wilfred Smith: *An Economic Geography of Great Britain*, Methuen, London, 1949, pp. 184–186. On the pivotal importance of sheep in this system, see H. G. Sanders: *Rotations*, Bulletin No. 84 of the Ministry of Agriculture and Fisheries, H. M. Stationery Office, London, 1944, p. 7.

[3] "Folds" are pens of portable fencing which can be shifted systematically to ensure intensive grazing, treading, and manuring of every part of a field (Fig. 5).

TABLE I

CHANGING SHEEP POPULATION IN SELECTED GROUPS OF BRITISH COUNTIES,* 1939–50

(Index numbers: 1939 equals 100)

Year	*Scottish Highlands*	*Welsh Uplands*	*Eastern Scotland*	*"Hunting Shires"*	*Southeastern England*
1939	100	100	100	100	100
1940	101	99	96	90	94
1941	91	89	80	74	76
1942	96	93	77	70	72
1943	99	98	72	54	64
1944	102	101	73	48	55
1945	102	102	73	50	50
1946	103	105	74	54	44
1947	89	70	66	52	35
1948	101	84	73	51	29
1949	106	94	77	59	28
1950	111	100	79	64	28

*The following counties are included within the respective groups: Scottish Highlands: Argyll, Inverness, Perth, and Ross & Cromarty; Welsh Uplands: Brecon, Caernarvon, Merioneth, Montgomery, and Radnor; Eastern Scotland: Aberdeen, Berwick, East Lothian, and Roxburgh; "Hunting Shires": Leicester, Northampton, and Rutland; Southeastern England: Berkshire, Dorset, Hampshire, Norfolk, Suffolk, and Wiltshire.

FIG. 5 (upper left). Southdown sheep folded on cabbage in Sussex. The fold is constructed of portable "hurdles" made of wattle; other wattle fences are visible in the background. (Photograph courtesy of *Farmer and Stockbreeder.*)

FIG. 6 (upper right). Oats planted on former sheep walks on the South Downs above Chichester. Such scenes are increasingly common on the Chalk Downs. (Photograph courtesy of *The Times.*)

FIG. 7 (lower left). Romney Marsh ewes with their spring lambs on an upland pasture in Kent. The "oast houses" in the right background are kilns for drying hops. (Photograph courtesy of *The Times.*)

FIG. 8 (lower right). Scottish Blackface ewes and lambs in the Southern Uplands of Scotland. The ewes were crossed with a Border Leicester ram to produce "Greyface" lambs. Note the dry stone wall, and the bare moorland rising in the background.

financial loss, in order to obtain the beneficial effects of "the golden hoof" for treading and manuring.

The grain and sheep farming system, with sheep folding on arable land, is closely associated with the distinctive Down breeds of sheep. All six Down breeds, of which the Southdown is perhaps best known, are characterized by black or grey faces and short wool of fine quality which is used in the manufacture of hosiery.[4] The Down breeds are noted for their rapid growth, early maturity, and high grade mutton. These qualities have created a demand for Down rams to be used in cross-breeding.

The grain and sheep farming system of the Chalklands proved uneconomic when mutton and grain prices dropped after the First World War, and was retained only where there was no profitable alternative.[5] Some farmers turned to mechanized grain production on a large scale with artificial fertilizers, or introduced sugar beets to provide additional cash income. Other Chalkland farms were allowed to "tumble down to grass," and the Down breeds were largely replaced by cross-bred sheep which could be run either on arable land or on grass. The initial success of cross-bred flocks was somewhat offset, however, by increasing problems of worm infestation and denuded pastures as a result of over-stocking dry upland grazings.

It appears improbable that the trend of declining sheep population in southern and eastern England will be reversed, if indeed it can even be halted. The arable grain and sheep farming system is too prodigal of labor to be competitive today; tending a grassland flock is vastly easier than moving fences and other paraphernalia from place to place in the arable field. It is also true that many Chalkland farmers, under war-time necessities, discovered that sheep were not as essential to soil fertility as had formerly been thought. The number of Southdown sheep—the premier Down breed—dropped from 55,000 in 1939 to 5000 in 1950.[6] The majority of the relatively few remaining arable flocks are producing pedigree stock for cross-breeding.[7] The demand for Down rams can be expected to continue, and even to increase slightly as the emphasis in British livestock production shifts from quantity, under austerity and rationing, to quality under free market conditions. Nevertheless, it would appear that the days of the commercial arable flock of Down sheep on the Chalklands are numbered, even though specialized ram-breeding flocks may continue to enjoy a limited prosperity.

The grassland sheep flock in south-eastern England also faces stiff competition. Pastures laid down between the wars were among the first to feel the pressure of the war-time Plough-up Campaign. A sustained demand for home-grown grain to replace imports of feeding stuffs has kept many former grassland areas under cultivation ever since. Increased grain production has been facilitated by improved agricultural machinery and new management concepts (Fig. 6). After an intensive study of one section of the Chalklands, for instance, Coppock concludes that the most widespread change in land use since 1931 has been the conversion of permanent grass to arable land.[8] Tave-

[4] The various British breeds of sheep are discussed at some length in J. F. H. Thomas: *Sheep*, Faber and Faber, London, 1945, pp. 22–41.

[5] For treatment of the modifications which were made in the grain and sheep farming system, see Smith, *op. cit.*, pp. 185–186, or Stamp, *op. cit.*, pp. 305–307.

[6] *The Times* (London), September 15, 1954.

[7] Thomas, *op. cit.*, p. 47.

[8] J. T. Coppock: "Land-Use Changes in the Chilterns, 1931–51," *Trans. and Papers, 1954, Publ. No. 20 of the Inst. of Brit. Geogrs.*, pp. 113–140, ref. on p. 130.

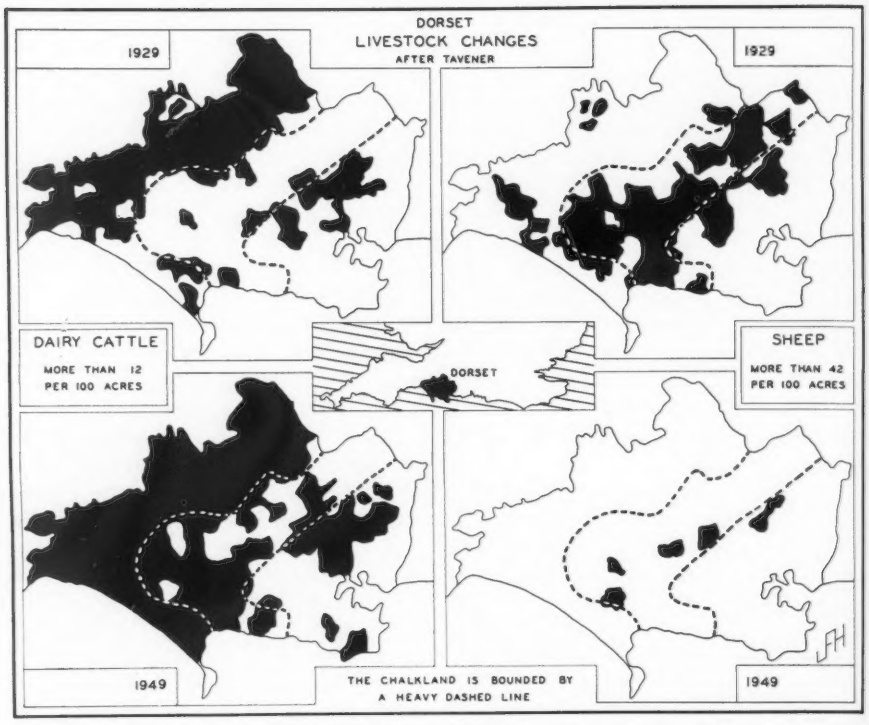


FIG. 9. Changes in density of sheep and dairy cattle in Dorsetshire between 1929 and 1949, after L. E. Tavener. (Reproduced by permission of the Council of the Institute of British Geographers.)

ner notes the same trend in Dorset, and concludes "over most of the Chalklands the arable-sheep farms based on sheep, cereals and roots have been replaced by more general farms based on cereals, cattle and fodder crops."[9] (Fig. 9.)

The increased urban population of southeastern England has also tended to reduce sheep numbers. Coppock notes "the spreading tide of bricks and mortar which covers ever larger areas with forbidding uniformity."[10] In addition to the demand for agricultural land for new housing, there is an increasing demand for fluid milk. Ever since the early 1930's milk has held a comparative price premium over sheep, and it appears that many grassland farmers in southeastern England are converting from sheep to dairy cattle (Fig. 10). An additional problem created by increasing urbanization in some areas, at least, is the townsman's dog which takes its exercise in chasing or killing sheep.[11]

Romney Marsh

The one part of southeastern England where sheep apparently are holding their

[9] L. E. Tavener: "Changes in the Agricultural Geography of Dorset, 1929–49," *Trans. and Papers, 1952, Publ. No. 18 of the Inst. of Brit. Geogrs.*, pp. 93–106, ref. on p. 96.

[10] Coppock, *op. cit.*, p. 139.

[11] Sir E. John Russell: *World Population and Food Supplies*, George Allen and Unwin, London, 1954, p. 39. Although one can find sheep flocks near urban centers where city dogs do not appear to be bothering the sheep, the problem is severe enough in some areas to have stimulated a spirited correspondence in *The Times* (London) during early August, 1954.

own obviously warrants separate consideration. Although much of Romney Marsh is below the level of highest spring tides, the name "marsh" is a misnomer, because the area is well drained by ditches.[12] If the permanent water table were slightly lower the alluvial soils of this area could provide excellent arable land, and considerable acreages have been plowed in the past. Today, however, Romney Marsh is dominated by pastures, which provide some of the richest and most intensively stocked grazing land in Britain.

Each acre of the better pastures can winter two or three ewes of the Romney Marsh (or Kent) breed. These are heavy, long-woolled sheep, so are commonly crossed with a Southdown ram to produce the popular small joint. Lambs are born in early April, and remain with their dams during the summer, when some pastures carry six to eight sheep and lambs per acre. Bleak weather, diseases, and the shortage of food make it inadvisable to winter lambs on the Marsh, so they are removed to upland farms in late summer (Fig. 7). Unless they have been winter-fattened on turnips by upland farmers the lambs are returned in the spring for grass fattening and sale at eighteen months.

Stamp points to the potential danger of over-dependence on sheep in the Romney Marsh area and the consequent desirability of diversification. He suggests several possibilities: introduction of more cattle; increased production of truck crops; greater emphasis on commercial seed production (grass, fodder roots, and vegetables). New enterprises would require considerable capital investment, however, so the traditional sheep economy has remained relatively well entrenched.

[12] For a detailed description of Romney Marsh and its agricultural practices, see L. Dudley Stamp: "Kent," part 85 of L. Dudley Stamp, ed.: *The Land of Britain, The Report of the Land Utilisation Survey of Britain*, Geographical Publications, London, 1936–46, Vol. VIII, pp. 604–606.

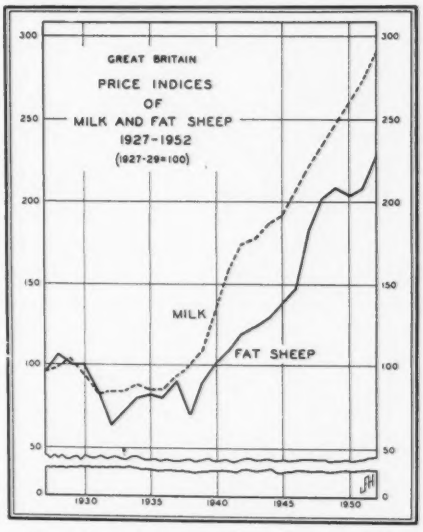


FIG. 10. Price indices for milk and fat sheep, 1927 through 1952. The average price for the period 1927–29 equals 100.

MIDLAND ENGLAND

Midland England, as here defined, stretches from the Chalk outcrop in the south and east to the margins of Highland Britain in the north and west (Fig. 3). The Midlands are intermediate both in location and in the trend of the sheep population. The decline in sheep numbers here has not been so severe as in the south and east, nor has it been so slight as in Highland Britain. The pattern of change is complicated by counties along either margin which are only partially in the Midlands, but the decline is obvious (Fig. 11). The sheep population of counties wholly in the Midlands dropped from around four million in 1874 to about two and a half million in 1938, and then to approximately a million and a half in 1951. It must be noted, on the other hand, that the sheep population of the Midlands

has shown the largest percentage increases in Britain since 1945, and it appears logical to assume that the number of sheep in this area might almost regain the level of the 1930's (Table I).

The discontinuous limestone uplands of the Jurassic scarplands were formerly characterized by agricultural systems and sheep densities generally similar to those of the Chalklands (*Cf.* Figs. 3, 4, and 11). The same processes which decimated the sheep population of the Chalklands have also been operative in the Jurassic scarplands. Dairying has been of increasing importance in the southwestern part of these scarplands. In Gloucestershire, for instance, where the majority of sheep were in the Cotswolds, the sheep population dropped

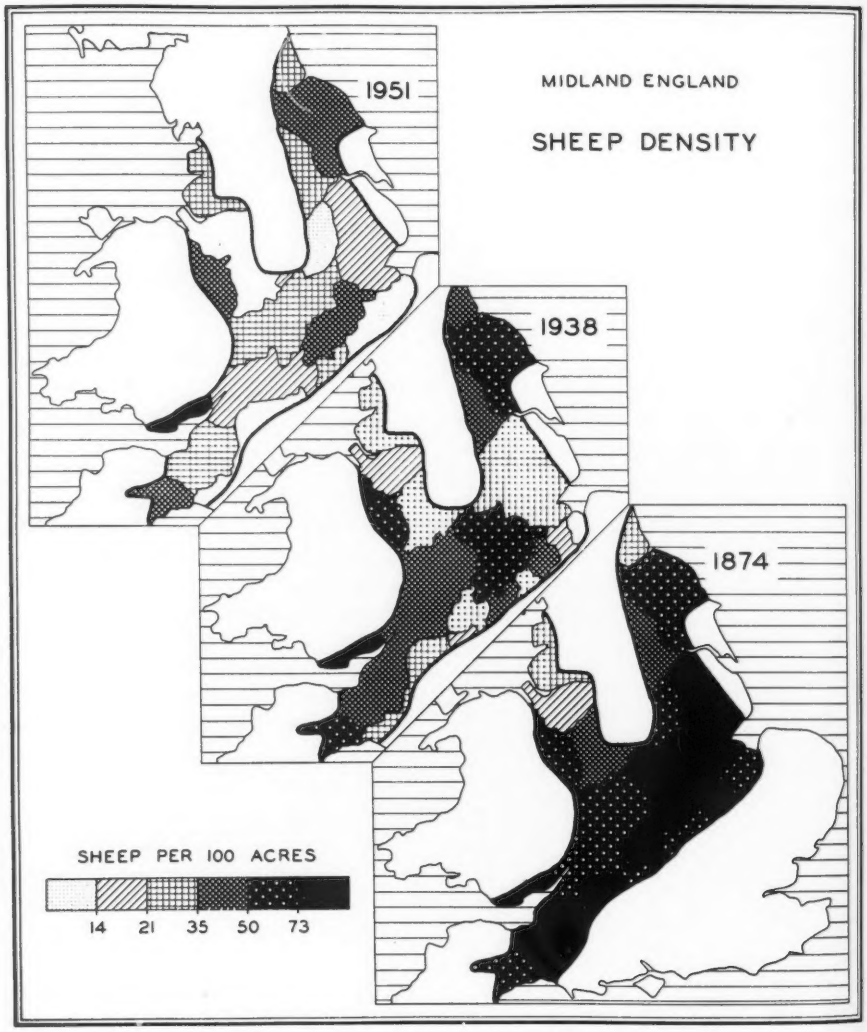


FIG. 11. Sheep density in Midland England, 1874, 1938, and 1951.

from about 500,000 in 1874 to about 300,000 in 1938 and about 200,000 in 1951; for the same years the cattle population increased from about 130,000 to about 175,000, and then to just over 200,000. There was increased emphasis on such new cash crops as sugar beets in the drier northeastern part of the scarplands, as in the northeastern Chalklands.

Sheep have traditionally been subordinate to cattle in other parts of the Midlands. In intensive dairy farming areas, such as Lancashire and Cheshire, the sheep population has remained low because the lambing season coincides with the end of the stall feeding period for cattle; the dairy farmer can hardly afford to have lambing ewes competing with his cows for the first flush of spring grasses. Throughout most of the Midlands, and especially around the southern flank of the Pennines, the declining sheep population can be explained by the rapidly increasing demand for fluid milk in growing industrial centers (Fig. 11). Over the last quarter century dairying has been steadily increasing both in and around the southern Pennines and in the Great Clay Vale just north of and parallel to the Chalk outcrop.

On the other hand, sheep complement rather than compete with fat cattle production on grassland farms. The densest sheep concentrations in the Midlands have been and still are in the cattle fattening areas of the eastern Midlands, and especially in the "Hunting Shires" of Northampton, Rutland, and Leicester (Figs. 2 and 11). Three-fifths of the agricultural land of these counties is under grass, and dairy cattle have not yet supplanted beef cattle and sheep.

The most common basis for sheep operation on a beef farm is the "flying flock." The farmer keeps no permanent flock, but buys enough sheep each fall to utilize his surplus feed. He may buy lean, or "store," lambs for winter fattening on grass or roots, but it is more common to purchase middle-aged ewes or ewe lambs for cross-breeding (Fig. 12). The spring-born lamb is fattened with its dam the following summer, and both are sold to make way for new ewes in the fall. The fact that the flying flock is operated on a year-to-year basis permits a considerable degree of flexibility. When feed is short the farmer simply does not buy sheep for wintering; when prices are such that he cannot anticipate a reasonable profit from fattening sheep, there are alternative uses to which he can put his surplus feed.

The operation of flying flocks is not restricted to the Midlands, nor is it restricted to any special breed of sheep. The farmer buys the best ewes available at the prices he wishes to pay and crosses them with a ram which will impart good mutton qualities to the lambs. Rams of the Down breeds are generally preferred, which accounts for the continued existence of specialized ram-breeding flocks of these breeds. Although there is apparently a relatively extensive local traffic in middle-aged ewes throughout Britain, by far the vast majority of the ewes constituting flying flocks come from hill sheep and stock rearing farms in Highland Britain.

Farmers on better land around the fringes of Highland Britain have the definite advantage of proximity to the major source of ewes for flying flocks, and before the war sheep fattening played a significant role in the economy of southwestern Wales, the Welsh Marches, and the Lowlands and the Northeast of Scotland (Fig. 13). In response to war-time demands these areas were able to place greater emphasis on arable cropping and dairying, at the expense of sheep, and the sheep population declined accordingly (Fig. 3). In terms of their changing sheep population

FIG. 12. A flying flock of Half-bred (by Border Leicester ram out of a Cheviot ewe) ewe lambs in the eastern Midlands. These ewes will be crossed with the Wiltshire Horn ram in the center. Note the hedgerow enclosing the field. (Photograph courtesy of *Farmer and Stockbreeder*.)

FIG. 13. A flying flock of Cheviot ewes and lambs near Edinburgh. The ewes, after bearing four crops of lambs on moorland farms, have been bought by a lowland farmer for this last lamb crop before they are fattened for slaughter. The moorlands of the Pentland Hills are prominent in the background. (Photograph courtesy of *The Scotsman*.)

these areas are more like the Midlands than like Highland Britain, although the sheep population of these areas did not decline as sharply as in the Midlands (Table I).

HIGHLAND BRITAIN

During the war and post-war period the sheep population of upland areas in Highland Britain remained more stable than in any other part of the island. Decreases are primarily attributable to natural factors, such as the severe winters of 1941 and 1947, and not to the national emergency as in the rest of Britain (Table I). The predominant land use of these upland areas is unimproved rough grazing, or "moorland," as the harsh environment virtually precludes crop cultivation.[13] The moorland areas have long been the home of hardy breeds of such "hill sheep" as the Cheviot, the Herdwick, the Scottish Blackface, and the Welsh Mountain (Fig. 8). The primary characteristic of these sheep is their ability to withstand the rigors of a moorland winter, and then lamb in the spring and recuperate during the summer. The carcass, although small, commands a premium because of its fine flavor, but the wool is not generally of the highest quality.

Sheep farming operates at two levels in the moorland areas. The hill sheep farms, in the highest areas with virtually no improved land, concentrate on production of store lambs to be fattened on better farms. In addition, there is commonly an annual surplus of middle-aged ewes which could produce another lamb or two, but not under harsh moorland conditions. The hill sheep farmer is completely dependent upon lowland farmers to absorb his annual surplus of lambs and over-age ewes.

Stock rearing farms are at lower elevations than hill sheep farms, and commonly have enough improved or improvable land to permit some diversification of farm operations. On the stock rearing farm ewes of a hill breed are crossed with a heavier ram to produce a larger lamb; the Half-bred sheep, by a Border Leicester ram out of a Cheviot ewe, is one of the better known British cross-breeds (Fig. 12). The cross-bred sheep of the stock rearing farm are sold to a lowland farmer for fattening or for further cross-breeding with a still heavier Down ram in a flying flock. Like the hill sheep farmer, the stock rearing farmer depends upon lowland farmers to provide a market for his sheep. The stock rearing farmer, on the other hand, is commonly able to fatten some or all of his own sheep when necessary, but the hill sheep farmer cannot. The stock rearing farmer is also able, in most instances, to maintain a small breeding herd of hardy hill cattle, or even of dairy cattle. His ability thus to diversify has enabled the stock rearing farmer to fare better, but only slightly better, than the hill sheep farmer; both have required governmental assistance in the form of loans or outright subsidies.

The economic plight of hill sheep farmers was so serious at the outbreak of the Second World War, after eight years of unbroken economic depression, that outright subsidy appeared to be the only adequate means of keeping the industry alive.[14] A direct cash payment

[13] For a more detailed survey of the moorland environment and economy, see John Fraser Hart: *The British Moorlands, A Problem in Land Utilization*, University of Georgia Press, Athens, 1955.

[14] The problems of the hill sheep farming community before the Second World War are treated in considerable detail in two official reports: Great Britain, Department of Agriculture for Scotland: *Report of the Committee on Hill Sheep Farming in Scotland* (Cmd. 6494), H. M. Stationery Office, Edinburgh, 1944; and Great Britain, Ministry of Agriculture and Fisheries: *Report of the Committee on Hill Sheep Farming in England and Wales* (Cmd. 6498), H. M. Stationery Office, London, 1944.

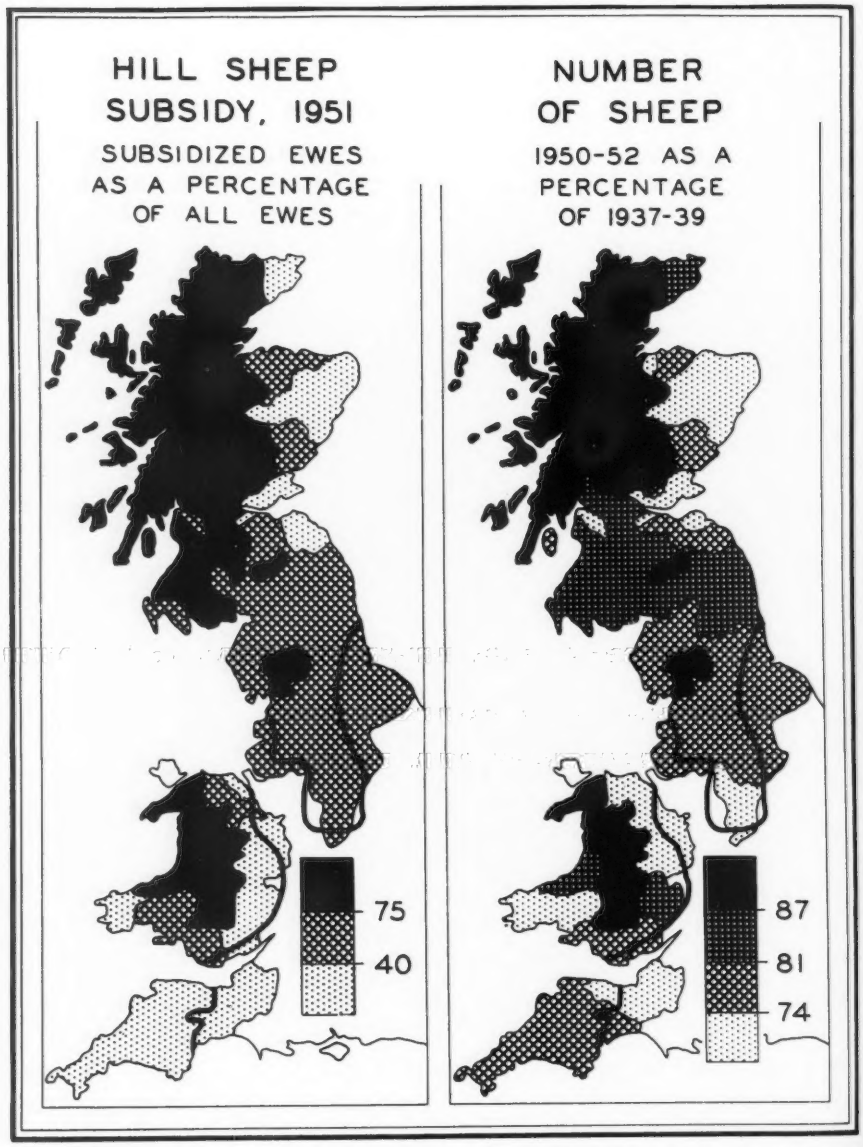


FIG. 14. Hill sheep subsidy, 1951, in relation to the changing sheep population of Highland Britain during the war and post-war period. The margins of Highland Britain are indicated by the heavy line.

for every breeding ewe was instituted in 1941. This hill sheep subsidy initially was justified on two grounds: (1) the necessity of maintaining maximum food production in moorland areas, and (2) the necessity of maintaining a reservoir of breeding stock for lowland sheep farmers.

Hill sheep subsidy payments were continued, at varying rates, through 1953. Although no subsidy was paid in 1954, the machinery was maintained, and a heavy rate of payment has been announced for 1955 to ameliorate the effects of the severe winter of 1954. Variations in subsidy payments from year to year result from governmental efforts to maintain the prosperity of hill sheep farming at or above the 1945 level.[15] Economic surveys in the immediate post-war years indicated that even the best hill sheep farms could have done little more than break even financially without the subsidy; the poorer farms presumably would have been abandoned.[16] A more recent study indicates that subsidies and grants provided the equivalent of two-thirds of the net income of a sample of hill sheep farms in Scotland in 1950–51.[17] There is close correlation between areas of heavy subsidization—where hill sheep are most important—and areas of comparatively stable sheep population (Fig. 14). Although factors other than subsidy obviously are operative, it appears that hill sheep subsidy payments have played a major role in maintaining sheep numbers on the moorlands of Highland Britain during the war and post-war period.

Although subsidies could maintain hill sheep farming, it became obvious during the war that necessary improvements could only be made with additional governmental assistance. The Hill Farming Act, 1946 (later modified and extended by the Livestock Rearing Act, 1951) provides for government payment of one half the cost of capital improvements on hill or livestock rearing farms. Grants under these Acts have proven especially valuable for improving pastures and other facilities on the better farms. These farms can then diversify their operations, and thus decrease their dependence on lowland markets while increasing the national food supply. It is nonetheless unfortunate that grants have also been made to poorer farms, which are not able to fatten their own sheep, and must sell them on the dwindling lowland market. Many of these poorer farms might better be put to other use, such as afforestation, which would make them more productive than they will be as hill sheep farms. The combination of subsidies and grants has undoubtedly encouraged the retention of sheep on inefficient upland farms, and thus has discouraged potential occupants who might have used the land more effectively in the national interest by putting it to other use.

CONCLUSION

Between 1938 and 1951 the sheep population dropped by approximately two-thirds in southeastern England, one-third in the Midlands, and only about one-sixth in Highland Britain. It appears valid to conclude that sheep numbers in southeastern England will increase slowly, if at all, and that pre-war figures will not be reached. Increases will be more rapid in the Midlands, at least for the next decade or so, but again there is considerable evidence to support the conclusion that the long-range declining trend will continue. It must be concluded, therefore, that the sheep population of Britain will be

[15] Personal communications from various officials in London and Edinburgh whose duties include the annual fixing of the hill sheep subsidy payment.

[16] D. Witney and W. B. Duthie: "Report on Financial Results of 46 of the East of Scotland Farms for 1945/46," mimeographed Bulletin No. 4 of the Department of Economics, East of Scotland College of Agriculture, 1947; also W. B. Duthie: "Report on Financial Results of 52 East of Scotland Farms for 1946/47," mimeographed Bulletin No. 12 of the Department of Economics, East of Scotland College of Agriculture, 1948.

[17] G. F. Hendry: "The Financial Results of Farming in 1950/51," *Scottish Agricultural Economics*, Vol. 3, 1952, pp. 9–18.

increasingly concentrated in Highland Britain. As demands on arable lowland areas increase even the sheep population in Highland Britain can be expected to decline except in moorland areas.

As sheep numbers in lowland areas decline, the justification for subsidization of hill sheep and stock rearing farms will depend increasingly on the ability of these farms to contribute to the national larder. Sheep farmers in the moorland areas should improve their pastures so that they can fatten their own animals, and indeed many are already doing so with the abundant government assistance which is currently available. On the other hand, the farmer who cannot fatten his own animals will be in increasingly sore financial straits as the sheep population of lowland areas decreases. In time his land may well have to be put to other use. If this is indeed the case, it behooves the agricultural authorities in Britain to ensure that no improvement grants or subsidies are made to the farm which will eventually pass out of agricultural use. Only thus can the hill sheep farmers of Britain be kept out of the ranks of the sugar beet producers of Germany, the wheat farmers of France, Sweden, and the United States, the rice growers of Italy, the wine makers of France, and the cotton farmers of the South, who together are creating one of the major economic and political problems of twentieth century agriculture—the problem of subsidized surpluses.

BOOK REVIEWS

Hawaii's People, by ANDREW W. LIND, with the technical assistance of Robert Schmitt. xii and 116 pp.; maps, diagrs., index. University of Hawaii Press, Honolulu, 1955. $2.75. 9 x 6 inches.

Thirty years ago Romanzo Adams first published his *The Peoples of Hawaii*. The relationship of Andrew Lind's new book to Adams' study is aptly expressed in the final line of the new work: "The peoples of Hawaii are becoming Hawaii's people." The rapid cultural assimilation and slower biological amalgamation that have been going on for many years are the major themes of the book, supported and illustrated by historical evidence, knowledge gained by the author during his long experience as a sociologist at the University of Hawaii, and the results of the 1950 census. This census, it is pointed out, gives "a full century of more than usually reliable statistical data."

The four main chapters of the book answer the questions "Who are they?", "Where do they live?", "How do they live?", and "What are they becoming?" Although the book is short and written for a general audience, an astonishing amount of information is packed into it. The typography is a delight to the eye and the text is a happy proof that social science does not demand a murky style. Much of the necessary statistical information is given in 27 well-designed tables, some of which coordinate lines and columns to give much detail in small space. Table 25, for instance, gives births from 1931 to 1950 by the race of the father (lines) and mother (columns), showing 81 different combinations. A geographer might like more graphs (there are four) and maps (only two). Such graphs as are presented are, however, so clearly drawn as to put some of us to shame. The population pyramids by race are especially instructive.

The geographer is likely to turn to the chapter on "Where do they live?" in search of population geography. He will be disappointed, but he can be consoled by the thought that the field is still open for a geographer. The map of the islands in this chapter is highly generalized, with "caterpillar" landforms, and shows very few of the place names mentioned in the text. Although the term "habitat" is used, there is no adequate description of it, nor is there, in the following chapter on "How do they live?", any real discussion of man-land relationships. There is more emphasis on such things as the urbanization of the various racial groups and the occupational mobility that has been a potent safeguard of democracy in the islands. A geographer should read the book for such sociological information, not for geography.

The map of Honolulu showing "ethnic islands" is in some detail, though it lacks the topographic information so necessary to visualize this city of striking landforms. Lind points out that few of these ethnic islands have remained pure. Honolulu's "Chinatown" has never been exclusively Chinese and in 1940 the Japanese outnumbered the Chinese there. The free and unembarrassed use of such terms as "Chinese Hollywood" and "Mandarin Heights" for other districts is a good indication of the high degree of racial tolerance in Hawaii.

Lind does not gild the lily. Although his love for the islands and their people is apparent, he remains objective. In Hawaii "the American profession of equality among all peoples is most nearly realized; but it is also apparent that the ideals frequently fail of realization." But racial friendship in Hawaii has gone so far that one can say that the problems are residual rather than fundamental. Lind is careful to point out that generalizations about Hawaii may not be applicable directly to other parts of the world. Nevertheless, the success of racial tolerance there leads one to hope that someday mainland America may be as free from prejudice.

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Geography of the Northlands. Edit. by GEORGE H. T. KIMBLE and DOROTHY GOOD. x and 534 pp., maps, ills., index. John Wiley and Sons, Inc., New York, 1955.

This book is the most recent contribution to the knowledge of the Polar Lands which has appeared in the American Geographical Society's series of Special Publications. "With the coming of aircraft . . . lands and seas which were inaccessible to men with boats and dog teams have opened up" and in the years during and since the Second World War a great deal of new knowledge about the north has been obtained. *Geography of the Northlands* reviews and appraises this knowledge which has hitherto appeared principally in professional journals as articles by those who have carried out research in this vast field.

The "northlands," for these purposes, have been considered as embracing the arctic and subarctic lands and seas of the world. They are defined on a climatic basis, after Köppen, for general use throughout the book. Unfortunately, the limits of the sub-arctic as stated are not

those usually attributed to Köppen, nor are they the same as those used by A. L. Washburn, the authority quoted for them. This aside, however, it is difficult to understand how such places as Kimberley, B. C. (p. 263), and Calgary, Alta. (p. 274), can be considered as sub-arctic. However, for special purposes, other limits are used. Thus, at the outset, the editors recognized the fact that there are still many "northern" problems to be solved, not the least of which are the limits of the environment in which they occur.

The area covered by the book is therefore large, but most of it, naturally, is in Canada and the Soviet Union. It is therefore fitting that ten of the 14 authors should have been "Canadians" at some time. Actually 12 were members of the "geography group" at McGill University, the only Canadian university with a Department of Geography that has made any serious effort at Arctic research. Two of the 12, Messrs. Skarland and Teal, became associated with the others at the now famous geography summer school at Stanstead, Quebec. The team of contributors is therefore a formidable one, well fitted for the task they set themselves.

The book is divided into two parts—the first consisting of 13 systematic studies and the second of 14 regional studies. The systematic studies cover the various aspects of the physical geography of the land and sea; population; transportation; natural resources and economic development. The regional chapters cover Alaska, Canada (in three chapters), Greenland, Iceland, Svalbard and Jan Mayen, Northern Scandinavia and the U.S.S.R. (in six chapters). Clearly rather more weight has been given to some regions than to others. Less than one-third of this part (66 pages), for example, is devoted to the Soviet Union. It is not surprising, therefore (indeed, it is anticipated in the preface), to find lack of space responsible for some over-generalization. However, this does not account for the statement on p. 278 where "Port Nelson . . . is rail-linked" to the south, as Port Nelson hardly exists as a settlement today and has never been located on a railway.

The political response to the northern environment, which is, after all, the ultimate response, seems rather casually treated even in the chapter entitled "Political and Strategic Aspects" which occupies a scant nine pages. Internal political arrangements within northern lands are sometimes mentioned in a way which would confuse the general reader. For example, page 337 tells us that "after 1869 . . . Rupert's Land became federally administered" while on page 315 is the statement that "in 1870 . . . the Northwest Territories . . . had been placed under a territorial government." Actually, "Rupert's Land and the North-Western Territory" were transferred to the Government of Canada in 1871.

There are some signs that the initial work was done some time ago. For instance, there is no mention of the Innuitian Region of Northern Canada (the map showing the main "geological" divisions of Canada on page 315 is out-of-date), or of Schefferville in central Quebec and very little of the literature published after 1951 is cited. There is no mention of the outstanding "Arctic Bibliography," the first volume of which came out in 1953. The selected references for the chapters on Greenland and Northern Scandinavia do not include the work of Trevor Lloyd who is well known for his geographical research in these areas and was, indeed, one-time Canadian Consul in Greenland. On the other hand, Bogdan Zaborski, who wrote all six of the chapters on the Soviet Union, seems to have covered the literature thoroughly in English, Russian, and German. But in any multi-authored book, uniformity of treatment is not easy to achieve, even if it is desirable, and any faults which *Geography of the Northlands* has are outweighed by its merits.

The maps and diagrams are well up to the standards one has come to expect from the American Geographical Society and cartographer Jean Paul Tremblay, while the photographs have been chosen with care and are most stimulating.

This is a book which is particularly useful at the present time when to be ignorant of the areas with which it deals "is a luxury no educated person can afford" (p. vii).

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The Shopping Center Versus Downtown, by C. T. JONASSEN. xviii and 170 pp.; maps, charts, tables. Bureau of Business Research, College of Commerce and Administration, The Ohio State University, Columbus, Ohio, 1955. $3.50. 9¼ x 6 inches.

Perhaps quite appropriately a study of the current state of flux in commercial site development has been conducted with support from the Highway Research Board of the National Research Council. Starting with a pilot study of shopping habits and attitudes in the Columbus, Ohio, area published in 1953, the Bureau of Business Research at the Ohio State University has conducted an intensive investigation of the relative attraction for shoppers of the central business district and outlying shopping centers. The earlier work in Columbus has been supplemented by studies of Houston and Seattle and preliminary conclusions have been presented in book form. Without doubt the most striking conclusion to be drawn from this work is that the power of transportation has not weakened in the establishment of functional areas within the urban region. The railroad may have

brought about major city growth in the United States, but the automobile has been powerful in reshaping this development into a form more suited to the operating characteristics of cars. A part of highway research is the determination of the influence of automobile movement on social and economic patterns, and it is in this interest that the Highway Research Board has sought answers to the question, "What degree and quality of influence has the motor age shopping center had on the central business district?"

In his book Dr. Jonassen has attempted to answer this question which has been of concern to geographers as well as to planners and sociologists. The factual material presented serves to substantiate many conclusions which others working in urban studies have drawn from observation and to do so in rather exact statistical values established by 600 interviews in each of three cities. It is unfortunate that the sample was so selected that a considerable number of shoppers in the group employed outside the residence in the daytime was overlooked. This raises a very fundamental question, whether the "shopping support" of the central business district is adequately represented. A survey of any central district will bring out the striking amount of "internal shopping" which goes on, purchases by clerical, managerial, and sales personnel during or just after their working day. If the basic thesis of this work, that there is a direct relationship between proximity to shopping center and selection of that center for shopping, is meaningful, it would be extremely interesting to know to what degree those employed in the center use the center for shopping.

Due to its traffic orientation, this study was set up particularly to determine the influence of parking conditions on the choice of shopping area. As might be anticipated, the difficulty of parking in the downtown area ranks first as a disadvantage of the central district of each of the cities. The next ranking disadvantage is found in the fact that the center is "too crowded," and in two of the three cities the third most important disadvantage stems from the congested traffic. When downtown traffic and parking conditions are considered from the viewpoint of the quality of the disadvantage, in every case more than half, and, in some instances, more than three-quarters of the respondents found downtown traffic "difficult" to "practically impossible." This evidence suggests that, for the driver, the street and parking conditions of our central business districts form the greatest barrier to their continued prosperity. Nevertheless, Jonassen finds that the "advantages" of the central district are considerable, notably with respect to the range of goods offered for sale, the pricing, the choice, and the general multiplicity of goods and services available.

As might be expected, the advantages of one type of shopping center prove to be the disadvantages of its opposite. Difficulty of access and parking are weaknesses of the center whereas ease of access and parking are strengths of the outlying shopping center. Variety of goods distinguishes favorably the downtown area and handicaps the suburban area. In addition, this study has examined the motivation behind the choice of shopping area from the social viewpoint. In this section of his report Jonassen makes his most original contribution to our knowledge of shopping centers. It is most useful to discover that the prestige factor in downtown shopping is considerable, that "the right people" are reputed to shop there, giving to the central business district those shoppers who value emulation of the social "upper classes."

In its total product this study appears to be most useful in presenting statistical substantiation of many of the observations on shopping districts and quantification of these habits and attitudes. Unfortunately, several fundamental weaknesses are apparent. The most striking of these is the failure to define, either in character or in extent, what is meant by downtown shopping areas or outlying shopping areas. Are the ethnic shopping districts commonly adjacent to the central business district included with that district? Do the neighborhood and "major business street" shopping centers qualify as suburban shopping centers or are none but the integrated outlying developments so classified? The lack of definition of shopping areas leaves the reader questioning whether the respondents understood the areas about which they were being asked. Even within the scope of the study, the evaluation of habits and attitudes in shopping, there appears to be a failure to attack the problem which might be summarized, "Would you use an automobile in downtown shopping if you could?" Jonassen concludes that between 40 and 55 per cent of persons shopping downtown use cars and states that, "The comparatively low percentages of persons who use the automobile for this purpose has an important bearing on the importance of parking and traffic difficulties, since these problems should not be expected to affect the large proportion of persons who do not use cars." The reader is left questioning what will happen if shoppers become more insistent on using cars for shopping in the face of costly and inefficient public transportation in cities.

This study by using basically the interview technique introduces an element which may worry the geographer. This is the strong likelihood of prejudicing the results by the selection of alternatives offered to the respondent. In several of the questionnaires included in the appendices it would seem that not all possible nuances of shopping support or the reasons for using the central or the peripheral facilities are offered. In some cases this prejudicing of the result seems rather fundamental as in Section IIB of the schedule where no possibility for lack of interest in the various attributes is present.

Not all people will either like or dislike every item and to generalize on such "shotgun" answers seems doubtful.

A final weakness of this study, which could easily have been avoided, is the basis of the determination of "distance" from shopping centers. Anyone experienced in cities should be most chary of using straight-line distance between residence and shopping center and no time qualification. Miles of traveling in a city may be a most unrealistic measure and the geographer is left wishing for an isochronal rather than straight-distance analysis of proximity.

Much as this study fails to answer all our questions about why people shop where they do, it does add significantly to our knowledge of this vital problem. It is to be hoped that additional work will be conducted in cities of the Northeast where public transportation is relatively more important and in smaller trade centers throughout the country where private transportation may be more significant.

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University of Wyoming

Location Factors in the Petrochemical Industry, by WALTER ISARD and EUGENE W. SCHOOLER. vi and 106 pp.; maps, charts, tables. U. S. Department of Commerce, Office of Technical Services, PB 111640, Washington, D. C., July, 1955. $3.00. 10½ x 8 inches.

This excellent study of industrial location factors and patterns is the result of cooperation between the Area Development Division of the Department of Commerce and the Arkansas–White–Red Rivers Basins Committee. The committee is a federal-state authority that submits to Congress recommendations on the development of land and water resources of this region which has not fully participated in the recent growth of the United States economy. Since industrial use of local resources within a region contributes significantly to regional prosperity, this report was prepared to indicate possible future developments. As the petrochemical industry cannot be considered in regional isolation the authors of this study had to proceed on a nationwide scale (excluding to some extent the Pacific Coast area) to discover the potential of the region.

The work begins with an admirably concise description of the processes and products of the petrochemical industry, which is defined as a producer of chemical elements and compounds derived from feedstocks consisting wholly or in part of petroleum or natural gas fractions. The products of petroleum refineries as well as similar products extracted from natural gas are excluded, as they are heterogeneous mixtures of several compounds. Relying particularly on forecasts of production and consumption made by the President's Raw Materials Commission (so-called Paley Report, Washington, 1952) the authors proceed to discuss the future availability of feedstocks for the industry in its geographical context. If natural gas or its derivatives are used as feedstocks, plants can locate in gas fields or anywhere along natural gas pipelines. However, feedstocks from petroleum refineries (light distillates and gases) are not produced in such large quantities as natural gas, and it is not economical to transport them by long distance pipeline. Plants relying on these raw materials must therefore locate in the vicinity of refineries, from which they receive their feedstocks by short distance pipelines. Despite this close geographical tie, these plants have virtually no influence on the location of feedstock producing refineries; thus the location of petrochemical plants using refinery feedstocks is determined by the location of refineries which results from a combination of quite different factors. As refining operations are unlikely to increase substantially in the Arkansas–White–Red River region, severe restrictions on the expansion of this type of plant can be expected there. This regional trend is reinforced by the anticipated general decline in the use of petroleum feedstock in the industry. However, there are exceptions to this general development forecast, as, for example, in the manufacture of propylenes (for antifreezes and detergents) and butylenes (for solvents and rubbers) which to some extent can locate away from refineries due to the use of easily liquefiable and transportable feedstock. These exceptions are unlikely to affect development in the region.

In view of the wide choice of locations for installations based on natural gas supplies, comparisons are made between plants located in gas field regions and plants located in regions of consumption in northeast United States (Middle Atlantic, Great Lakes regions, etc.). Cost of plants, maintenance, labor, etc., are shown not to vary significantly between different locations. The investigation, therefore, is reduced to a discussion of regional transportation cost differentials and possible economies in the scale of operation in the various regions. The latter is determined by the location of the plant; installations in or near gas fields can supply the national market, while plants in consumption regions are limited to their smaller regional markets. The authors conclude that petrochemical production will tend to be associated with large scale plants which in general will favor locations in natural gas field regions, as for example in the Arkansas–White–Red River region. In view of the advantages of water transportation these plants will preferably be located at tidewater or suitable river terminals. Some expansion will also take place away from natural gas fields near large metropolitan centers and at regional gateway points

along pipelines. Advantages in the cost of power may help the Middle Ohio valley to qualify as a desirable gateway location for the production of chlorinated products, which are obtained by a different process than the other petrochemicals.

By breaking down these general trends into observations on particular products and processes the authors estimate that by 1975 petrochemical plant capacities in the Arkansas–White–Red River region will have expanded by a minimum of 6 billion lbs. capacity (1951 U.S. capacity 8.6 billion lbs.). Under present technological conditions this increase of capacity will employ over 2200 additional production and maintenance workers. The authors admit that for "a few petrochemical products the data of our analysis are qualitatively poor and misleading (p. 44)." This affects the regional forecasts in particular. However, they add, "It is much less likely that this is the case for the petrochemicals taken as a whole."

The question arises whether the many input and cost data prepared with the help of many government and corporation officials are really significant in view of possible statistical duplications, different methods of by-product cost calculation, and probable technological changes. The authors have realized these limitations, but since their conclusions accord with logical deductions there can be no objection to their procedure. Geographers can profit from this study by observations on the methods of analysis and the skilful handling of the data. The reviewer regrets that the work does not refer to the effect of the freezing-up of inland waterways (incompletely expressed by freight rates) on plant locations. Presumably due to lack of data, the possible effect of new means of natural gas transportation in frozen form on special ships (undergoing trials since 1953) is not discussed.

Three sketch maps illustrate plant locations in 1930, 1940, and 1950. Unfortunately, the maps do not indicate sizes of plants, which gives an exaggerated impression of the dispersal of the industry. Today, about 85 per cent of the petrochemical capacity of the United States is concentrated in a few plants in the western portion of the Gulf coast, where the expected rate of growth is very high.

ALEXANDER MELAMID

New School for Social Research

Brasil, La Gran Potencia del Siglo XXI, by ANTONIO MEIJIDE PARDO. 410 pp.; maps, charts, bibliogr., index. Porto y Cia., Santiago de Compostela, Spain, 1955. 90 pesetas. 6¼ x 8¾ inches.

This is a book of substantial size dealing with the "geo-economic structure" of Brazil and the country's future possibilities. It is the first book of its kind written in Spanish by a Spanish geographer.

The range of material covered is wide. The author starts with the physical base, emphasizing the enormous extent of territory and the simplicity of surface configuration combined with climatic diversity. He then discusses the distribution and density of population and its rate of growth, and the history of immigration. The story of the settlement of Brazil is told historically, and this is followed by a chapter describing the successive economic cycles. Four "geo-economic" regions are recognized: the superhumid Amazon, the Northeast, the Meseta, and the Temperate South. Chapters then deal with agriculture, mining, industrial growth, and circulation. The last chapter looks into the future with a discussion of ultimate population capacity, and of the economic sectors of the plans for development.

From the point of view of the technique of geographic presentation the maps leave much to be desired. Economic maps are highly generalized and lacking in precision. Information is presented by States—which in a country the size of Brazil leaves one with a very vague idea of the basic facts of geography. But more serious is the failure to think in precise geographic terms. Perhaps in part because the author has not come close enough to his subject, he tends to accept uncritically the view that Brazil will some day be among the world's great powers. There is no part of Brazil, he reports, that cannot be used to support a greatly increased number of people; Brazil could support between 700,000,000 and 1,200,000,000 people. The density per square kilometer, he goes on, would only be between 83.3 and 141.1. No one who knows Brazil could suppose that the country could ever support a uniform density of population. Such an idea does violence to the basic concepts of geography.

"Brazil will be the great power of the 21st Century." A glance back at history or a critical examination of this country's physical resources suggests caution. There was a time when "the 20th century belonged to Brazil." Yet for some reason Brazil remains underdeveloped, with low income per capita, with its vast resources still not translated into economic values. Under these circumstances it would not seem proper just to repeat polite and somewhat emotional clichés about "this great and friendly member of the Hispanic family." A real geographic appraisal calls for something else—just as your physician, even if he is your friend, does not say "you have a tremendous body and in a few years you will be one of the world's biggest men." Rather it is his duty to tell you if you are sick, and why.

PRESTON E. JAMES

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Transportation in the Wisconsin Economy, by WILLIAM H. DODGE. 103 pp.; maps, tables. (Wisconsin Commerce Reports, Vol. IV, No. 4) University of Wisconsin, Bureau of Business Research and Service, 1955. $1.15. 11 x 8½ inches.

Mr. Dodge's report is of particular interest to those geographers who are concerned with the analysis of transportation patterns as a systematic approach to regional studies. Although the work is not intended as a geographic survey, it does suggest techniques by which regional economic geography can be made more comprehensive and comprehensible through investigation of transportation media.

"The purpose of the . . . study is to bring the transportation factor in the Wisconsin economy into perspective through a comprehensive review of the state's locational relationships with other states and an analysis of Wisconsin's transportation system" (page 9). The work is organized into three parts: Chapter I, on the economic and locational structure of Wisconsin, examines the competitive position of Wisconsin on a distance-to-market basis; Chapter II reviews the state's internal freight traffic pattern; and Chapter III discusses "facilities, services and rates" of Wisconsin freight carriers.

A most interesting segment of the study is that containing "access to national markets" figures and maps which compare the relative positions of leading manufacturing states by their weighted mileage distances to national consumer, industrial, and agricultural markets. These data are derived from total mileages between states (total ton miles of freight moving between two states divided by the total tonnage involved) and from the number of potential customers in each state. "Thus, population-weighted mileages can be used as a measure of the accessibility of consumer markets, mileages weighted by manufacturing employment as a measure of the accessibility of industrial markets, and mileage weighted by gross farm income to measure the accessibility of agricultural markets" (page 20).

On the basis of actual tonnage and ton mile data, therefore, Mr. Dodge has considered the same problems of comparative positions of states with respect to national markets studied by Chauncy Harris ("The Market as a Factor in the Localization of Industry in the United States," *Annals of Assn. Amer. Geogrs.*, Vol. 44, 1954, pp. 315–348) using estimated distances and estimated transportation costs. Although they used different criteria and Dodge considered only state, not county, units, the two authors agree that Wisconsin, located on the northwestern edge of the main manufacturing and population belts of the United States, is poorly placed for consumer and industrial markets but more favorably located for an agricultural market. In addition Dodge points out that, since freight traffic density is related to the degree of population and economic concentration, Wisconsin stands between the high densities of the industrialized Northeast and the low densities of the Northwest. Within the state itself, highest freight traffic densities occur in the highly industrialized Southeast and along the interstate "bridge" routes.

Mr. Dodge has dealt admirably with the very difficult problem of assessing relative significance of motor truck transportation. To supplement available federal, state, and private data he conducted a special traffic survey by questionnaires to over 650 Wisconsin firms employing 50 or more persons. Although the survey results do not completely assess the importance of truck transportation to Wisconsin manufacturers, the data indicate that trucks pick up more than one-half of the agricultural manufactured commodities and metal shapes and forms, and deliver more than two-thirds of the fabricated metal products. In all other categories reported either trucks were much less important than rail shipments or the data were not indicative of the relative positions of the two transportation media. In Wisconsin, apparently, motor truck shipment is less significant than it is in the more populous and industrialized Northeast in comparison to rail transportation.

Unfortunately, *Transportation in the Wisconsin Economy* does not completely achieve its stated objectives. The brevity of the study precludes the kind of exhaustive investigation of correlations between transportation patterns and the location of economic activity that would make a major contribution to the literature of regional transportation geography.

JEROME D. FELLMANN

University of Illinois

Comparative Population and Urban Research Via Multiple Regression and Covariance Analysis, by DONALD J. BOGUE and DOROTHY L. HARRIS. vii and 75 pp. Studies in Population Distribution No. 8, 1954. $0.90.

Suburbanization of Manufacturing Activity Within Standard Metropolitan Areas, by EVELYN M. KITAGAWA and DONALD J. BOGUE. vi and 162 pp. Studies in Population Distribution No. 9, 1955. $1.80.

Suburbanization of Service Industries Within Standard Metropolitan Areas, by RAYMOND P. CUZZORT. vi and 71 pp. Studies in Population Distribution No. 10, 1955. $1.05.

Published jointly by Scripps Foundation, Miami University, Oxford, Ohio, and Population Research and Training Center, University of Chicago, Chicago, Illinois. Each monograph 11 x 8½ inches.

These monographs are three in a series of Scripps Foundation studies under the direction of Donald Bogue that are concerned with the spatial distribution and growth of population and economic activity within the principal standard metropolitan areas of the United States. The basic outline of the system of statistical analysis employed in the studies of manufacturing and service industries is explained and carefully outlined with illustrative application in the first monograph (Study No. 8). Measurement of the various dependent and independent variables dealt with in Studies No. 9 and No. 10 is made possible through elaborate reliance on census data—United States Censuses of Manufactures for 1929, 1939, and 1947, United States Censuses of Business for 1939 and 1948, and United States Censuses of Population for 1930, 1940, and 1950. It is plausible to assume that a similar study of retail activities within S. M. A.'s is planned in this series.

The primary objectives of Studies No. 9 and No. 10 as stated by the authors are to explore a variety of factors believed to affect the interarea metropolitan arrangements of the manufacturing or service activities, and to provide an explanation of certain spatial variations and changes observed within individual S. M. A.'s with particular reference to the degree and rate of suburbanization. Explanation is accomplished through careful formulation and statistical correlative testing of a series of hypotheses relating to metropolitan spatial associations between manufacturing (or service) activities and certain demographic and other factors. The correlative procedures are those of multiple regression analysis, analysis of variance, analysis of covariance, with explanations made more meaningful through the use of beta coefficients.

The sequential presentation of material and findings is essentially the same for both manufacturing and service activity studies. A preliminary chapter introduces the problem under consideration along with a descriptive statement of general trends in the spatial distribution of each economic activity and population, and of the degree of their concentration in S. M. A.'s. This is followed by a more detailed analysis of variations in the extent of suburbanization for all S. M. A.'s, by regional groupings and by other subclassifications. Descriptive characteristics are completed by a chapter devoted to differences among individual S. M. A.'s in the degree of and tendencies toward suburbanization. The primary statistically explanatory aspects of the studies are detailed in remaining chapters devoted to multiple regression analysis of factors related to suburbanization of manufacturing or services activities, although an additional chapter has been added in Study No. 9 to present a series of reports by city plan commissions and other local agencies describing factors responsible for unique aspects of manufacturing location in particular S. M. A.'s. A final chapter in both studies summarizes findings with conclusions and implications. An appendix of statistical tables is provided also for those who wish to examine crude data of the various dependent and independent variables for each S. M. A.

Since these monographs are concerned primarily with a complex of associations and variations in association between phenomena in interarea metropolitan arrangement, the economic and urban geographer will find that these studies make a valuable contribution to the fund of geographic knowledge. This is true even though the authors orient their problem and findings in terms of "ecological factors," "human ecology," or "urban sociology." The studies also serve to point out that geographers have been lax in accepting statistical correlative procedures in geographic research, preferring to rely too heavily on visual correlations through the use of maps or to infer rather than to measure in a rather precise manner when possible the nature and degree of spatially associated phenomena. Further, the success in the accomplishments of each study as well as the strict comparison of findings in the two studies pointedly illustrates the importance of problem stating and the formulation of hypotheses as a basis for lines of inquiry in scientific investigations.

GEORGE W. HARTMAN

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Land Tenure. Edited by KENNETH H. PARSONS, RAYMOND J. PENN, and PHILIP M. RAUP. xxiv and 739 pp.; 1 map, index. University of Wisconsin Press, Madison, 1956. $10.00. 10¼ x 7 inches.

Land Tenure is a fine book because it reports the proceedings of an unusually fine international conference (International Conference on Land Tenure and Related Problems in World Agriculture, Madison, 1951).

For, at this conference, a group of earnest people from all parts of the world talked and worked together, in a frank and forthright way, about a problem of the utmost importance to mankind. The delegates, many of them public administrators, discussed the land tenure problems of their countries with a candor that seemed to confirm the editors' assertion that "They spoke for themselves and not as officials of their countries." Emphasis was upon the problems as they are, and what can be done about them, rather than on the accomplishment of government programs, although the latter were not overlooked.

Land tenure, in the broadest sense of the

term, was the subject of the conference. All of the important problems in man-land relationships in agriculture were dealt with. Because these problems loom so large in human welfare around the world, one can hardly fail to improve his world perspective if he studies these conference proceedings. An American will understand more clearly why Communism has been able to make inroads in some countries. For it is apparent that in a good many parts of the world, the ordinary folk do not get a very fair deal from their own countrymen who are in positions of power.

The problems of land tenure and related problems in agriculture are the problems of most of mankind. In most countries where agriculture is the primary source of livelihood, either or both of two circumstances are usually prevalent: (1) land holdings per family are too small to permit more than a bare subsistence; (2) land is in control of landlords who control the division of production to their advantage and to the disadvantage of the farmers. Under these circumstances, farmers never save enough to buy the tools to increase their efficiency and a situation is perpetuated where most of the population has to engage in farming to produce the necessities of life.

The different measures of land reform undertaken to overcome these circumstances are all discussed and to some degree evaluated in *Land Tenure*. These measures are of course not limited to redistribution of land holdings. They include resettlement, improved leasing arrangements, cooperative provision of services, collective farming, credit and technical services from public sources, and the various means by which these things are undertaken.

The rather contrasting experiences provided by two particularly significant nation-wide land redistribution programs, those of Mexico and Japan, are described by persons in a position to appraise them, as are the land reform programs of many other countries. The problem of fragmented holdings and the land consolidation programs aimed at it in various countries are analyzed and the effect of inheritance practices in fragmenting holdings given attention.

The experience of England and other countries that have provided equitable landlord-tenant arrangements by law are dealt with and show that tenancy is not necessarily an evil, and owner-operatorship not a necessity to insure economic opportunity and security in farming.

The threat of accelerated population growth offsetting the gains from better tenure and technology was stressed by some of the participants. In fact, one of the most provocative discussions in the whole conference, I am sure, was that which touched on the question of whether permanent gains in rural welfare can be expected if human population growth can only be controlled by the semi-starvation imposed by food supply.

The geographic differences in land tenure and related problems are highlighted by reports from every continent and most important countries.

This is a much more readable book than one usually expects a volume of conference proceedings to be. This I think must reflect the dedicated spirit of the conference, superior planning and organization, and an exceptionally good job of editing. This is not just a book for students of land tenure, or of land economics, or of agriculture. It is by all means a book for geographers. It is documentation of the efforts of people from all parts of the world to help each other understand and do something about one of the greatest of problems. The spirit of this conference is perhaps characterized by Mr. Dantwala, delegate from India: "You understand a people better when you understand their difficulties, not so much in regard to the dramatic issues of international tensions but in regard to their everyday life. In my humble opinion, such an understanding is a better befriender and has more winning powers than financial and military assistance."

CARLETON P. BARNES

Washington, D. C.

Las Heredades de Aguas de Gran Canaria, by JUAN HERNANDEZ RAMOS. 108 pp.; ills. Imprenta Sáez, Buen Suceso 14, Madrid, 1954. 8½ x 6 inches.

Irrigation was already an ancient institution in the Canary Islands at the time of their conquest, early in the 15th century. The conquerors perfected the system, thanks to the knowledge they had acquired from the Moors. Royal *cédulas* in 1480 and in 1505 confirmed *de jure*, in their rights to water, those families who had been enjoying those privileges since time immemorial. The author points out that what was originally a natural desert—useless to man—has been transformed into a colorful mosaic of cultivated fields, often referred to as a marvel of nature, in reality a miracle of man's occupancy. Depending on the vagaries of the international market, land now in bananas has successively been planted in sugar cane, in grapes, in nopal for cochineal, and in sugar cane again; and these changes have been effected by closely knit groups, without the help or intervention of outside agencies of any kind. In concluding this well-illustrated little volume, the author laments the fact that wells are being drilled in such numbers—for the most part by nonagriculturalists—that the old springs and watercourses have already ceased to have their accustomed flow, thus directly prejudicing those holders of ancient rights—las heredades—which should be guarded.

RAYMOND E. CRIST

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